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ARMIDALE REGIONAL LANDFILL
Environmental Assessment

Volume 3

ARMIDALE REGIONAL LANDFILL

Environmental Assessment - Volume 3 Technical Appendices E - H

Prepared for
Armidale Dumaresq Council
135 Rusden Street, Armidale NSW 2350

April 2010

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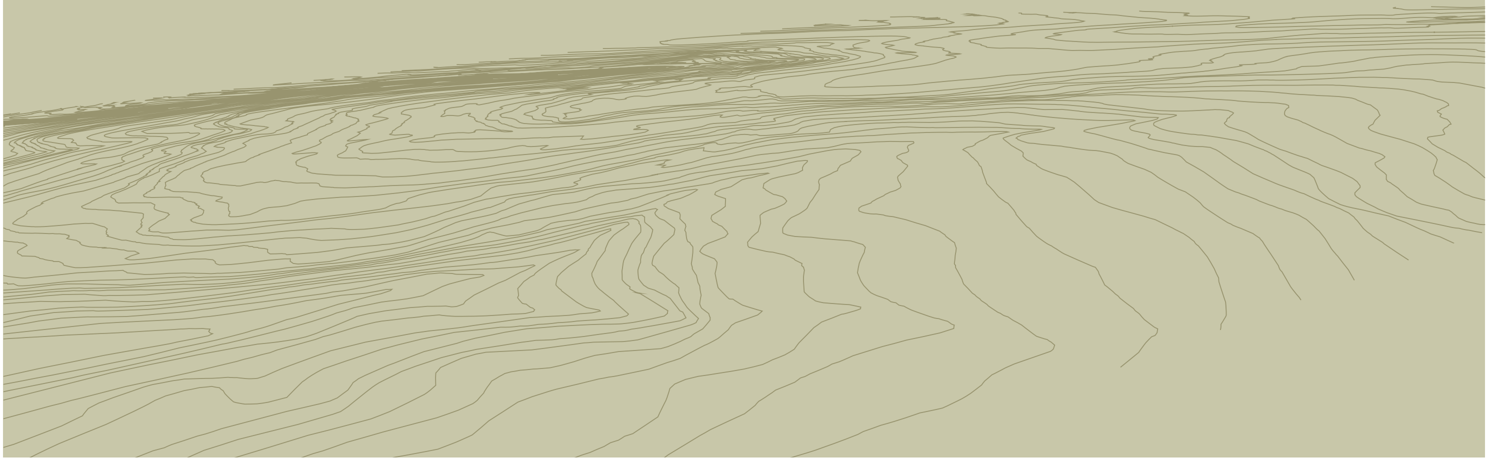
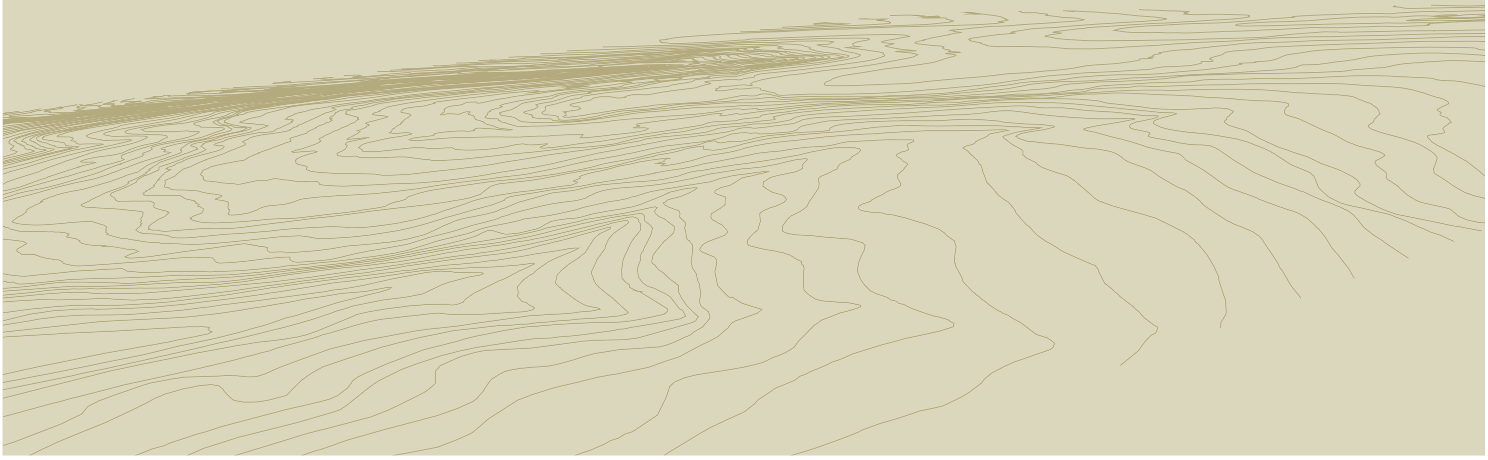


Appendix E

EA Systems, 2009: Flora and Fauna Assessment

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



~ Commercial-in-Confidence ~

Flora and Fauna Assessment

Proposed New Armidale Landfill Facility

Report Number 22678.31292

Prepared for

AECOM

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This document provides information to address the intent of Project Number 22678 as agreed to by AECOM.

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Executive Summary

E.A. Systems was engaged by AECOM on behalf of the Armidale Dumaresq Council to conduct a flora and fauna and habitat assessment over an area of approximately 315 ha for the proposed development of a new regional putrescible landfill facility to be located 12 km east of Armidale on Waterfall Way. This facility is expected to have an operational life of 50 years. The proposed landfill site will be developed on portions of two rural properties, *Sherraloy* and *Edington,* and a small strip of the adjacent *Gara Travelling Stock Reserve* (TSR) for site access. The development application for this proposal will be assessed under Part 3A – Major Projects of the Environmental Planning and Assessment Act (EP&A Act 1979). The format for this assessment is in accordance with the working draft Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities, November 2004 (Table A).

The aims of the flora and fauna assessment for the Armidale Regional Landfill proposal were to consider: i) the character and conservation value of existing flora and fauna which may be impacted either directly or indirectly by the proposal; ii) the significance of all potential impacts in the regional context; and iii) measures required to minimize impacts to natural and biological values on the proposed landfill site.

The significance of impacts of the proposed new landfill on threatened species, endangered populations or endangered ecological communities listed under the NSW *Threatened Species Conservation Act* 1995 (TSC Act) were assessed in accordance with guidelines set out in the *TSC Amendment Act 2002.* The assessment also considers the impact of the proposed development on matters of national environmental significance listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An assessment of potential Koala habitat was undertaken to address the requirements for *State Environmental Planning Policy 44 - Koala Habitat Protection.*

Threatened species databases and information sources, such as the Department of Environment, Climate Change and Water (DECCW) Threatened Species Profiles, NSW NPWS Wildlife Atlas, Birds Australia records and the EPBC Protected Matters Search Tool, were reviewed to identify the listed threatened species, endangered populations, endangered ecological communities and key threatening processes relevant to the survey area. The habitat requirements for each of the species listed were considered during the survey and habitat assessment.

The flora and fauna survey and habitat assessment of the study area was conducted during autumn (29-30 March 2005) and spring (18-19 October 2005). An additional survey was undertaken on 18 September 2006 to assess the impacts of the proposed access route through the Gara TSR adjacent to Waterfall Way. A final fauna survey was conducted on 23-24 November 2009 to search for any signs of Koalas in the TSR or at the landfill site. The current location of the Little Eagle nest observed in 2005 was also targeted in November 2009, in addition to a search for five species of birds for which a final determination under the TSC Act is currently pending (2009).

The fauna surveys recorded 80 bird species (1 exotic; 2 threatened, 3 provisionally listed as vulnerable), 15 mammal species (4 exotic; 2 threatened), 9 lizard species, 1 turtle and 8 frog species. The flora surveys recorded 11 trees (1 threatened), 29 shrubs (3 exotic), 3 climbers/vines, 2 mistletoes, 35 grasses (7 exotic), 98 herbs (24 exotic) and 2 aquatic plants. Five distinct vegetation communities occur on land that will be directly impacted by the proposed development: Box Gum Woodland, cleared grassland; sedgeland (drainage areas); wetland (farm dams); and Stringybark Woodland.

A 200 m strip of the proposed access route passes through a partially cleared section of the endangered ecological community (EEC) Box Gum Woodland on the Gara TSR. The remainder of the access route (1 km) passes through the cleared grassland and sedgeland. The area required for construction of infrastructure and retention ponds includes cleared grassland and sedgeland. The area required for the construction of the landfill operational area is predominantly within Stringybark Woodland and also includes a portion of cleared grassland and wetland (two small farm dams).

A number of potential impacts of the proposal on native flora and fauna have been identified. These include vegetation clearing, habitat loss, fire, fragmentation and reduced connectivity, weed invasion, pest animals, and consequences arising from traffic, dust, noise, pollution, litter and illegal dumping. The proposed development will result in the loss of 12.7 ha of Stringybark Woodland, 0.6 ha of Box Gum Woodland in the TSR, 6.5 ha of grassland, two small farm dams and 0.5 ha of sedgeland draining into the Gara River. Such disturbances reduce the habitat quality of the affected land and may threaten viable populations of threatened species found on the subject site.

No groundwater dependent ecosystems have been identified in the study area or in the Oxley Wild Rivers National Park downstream of the proposed new landfill (DNR 2002). Thus, the proposed new landfill is not likely to have any impacts on groundwater dependant ecosystems in the study area or further downstream in Oxley Wild Rivers National Park.

Proposed mitigation measures which address direct and indirect impacts on native flora and fauna are outlined in the report. These measures include traffic control, erosion and drainage control, plans for the management of weeds and pests, bushfire, landscaping and rehabilitation, groundwater and surface water quality and a number of other conservation management actions undertaken to enhance the biodiversity value of remnant native flora and fauna in the study area.

Five threatened species (Narrow-Leaved Black Peppermint *Eucalyptus nicholii*, Speckled Warbler *Pyrrholaemus sagittata*, Diamond Firetail Finch *Stagonopleura guttata*, Eastern Bent-Wing Bat *Miniopterus schreibersii oceanensis* and Koala *Phascolarctos cinereus*) were found on the study area. Two threatened species, Hooded Robin *Melanodryas cucullata cucullata* and Little Lorikeet (*Glossopsitta pusilla*), have previously been recorded adjacent to the study area. Three species for which preliminary determination exist and final determinations are pending under the TSC Act were recorded: Little Eagle *Hieraaetus morphnoides* (landfill), Scarlet Robin *Petroica boodang* (TSR & landfill), and Varied Sittella *Daphoenositta chrysoptera* (TSR & landfill). One Rare or Threatened Australian Plant (ROTAP) tree species, Bendemeer White Gum *E. elliptica* was recorded in the TSR. One EEC occurs on the Gara TSR: *White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland).*

The numbers of Narrow-Leaved Black Peppermint and Bendemeer White Gum on the site are small and confined to areas of the TSR that will not be directly impacted by the development. Foraging habitat for the Eastern Bent-Wing Bat occurs on the study area. This bat roosts in caves or man-made structures. However, there is currently no roosting habitat suitable for this species available on the site. Thus the proposed development will not have a significant impact on local populations of Narrow-Leaved Black Peppermint, Bendemeer White Gum and Eastern Bent-Wing Bat.

The location of the proposed access road through the TSR does not contain core Koala habitat. The location of the proposed landfill operational area does not contain core or potential Koala habitat. In March 2005, one Koala was recorded on the TSR, but was not observed in 2009. Evidence of Koala presence (scats and scratches) was recorded in the landfill footprint area in 2009, but the site is not primary habitat for Koalas.

It is concluded that the loss of habitat due to the proposed development will have a significant impact on local populations of two threatened woodland birds (Diamond Firetail Finch and Speckled Warbler) and two provisionally listed birds (Scarlet Robin and varied sittella) that have been observed on the proposed landfill footprint area. Habitat lost to development on the site will be offset by setting aside adjacent areas of similar vegetation type that are likely to respond to conservation measures which will permanently improve biodiversity values of the offset area (see Offset Management Plan). DECCW has stated that an offset ratio of 3:1 is required. Therefore, the proposed development will include an area of 40 ha of Stringybark Woodland that will be set aside and managed for conservation to compensate for woodland lost to development. An offset of 21 ha of cleared grassland will be set aside for conservation and will be revegetated with locally sourced woodland tree and shrub species. The details of the Offset Management are presented in a separate report.

Stringent controls will be put in place to ensure that there is no discharge of contaminated waters to the surrounding environment. These controls will be in accordance with the NSW DECCW Environmental Guidelines for Solid Waste Landfills. Management plans will be implemented for on-site control of weeds and pests and to prevent their spread off-site. Rehabilitation, landscaping and vegetation management plans will also be put in place to maintain and enhance biodiversity values of the site and to minimise adverse impacts on threatened flora and fauna. Implementation of the proposed mitigation measures will minimise onsite and offsite impacts on threatened biodiversity and will prevent any significant impacts on the World Heritage listed Oxley Wild Rivers National Park (4 km downstream of the proposed new landfill).

In order to ensure effective implementation of the proposed mitigation measures it is recommended specific management plans be developed to address key potential impacts. The recommended management plans are listed below (issues dealt with in other sections of the Environment Assessment are marked with an*):

- Vegetation Clearing Protocol
- Native Fauna Management Plan
- Fire Management Plan
- Weed Management Plan
- Pest Management Plan
- Disease Monitoring Protocol
- Dust Management Plan*
- Noise Abatement Plan*
- Pollution and Litter Management Plan*

Table A. Format of the Flora and Fauna Assessment report following the guidelines set out in the DECCW draft survey and assessment guidelines (DEC, 2004)

Section	**Content**
Executive Summary	A brief description of the study and its findings.
Definitions	Explanation of technical terms used throughout the report, including acronyms and abbreviations.
1 Introduction	An outline of the the legislative requirements, aims and objectives; a description of the proposal; details: regional context; location, geology, soils, landforms, climate and disturbance history.
2. Methods	Details the desktop and field survey methods employed for the assessment: outlining the consultation process, data sources, the selection of stratification units, flora and fauna survey methods, habitat assessment, and data analysis methods.
3. Results	Summarises the findings of the study, including: baseline surveys of the site and targeted surveys to detect species, populations and ecological communities listed under the TSC Act and the EPBC Act, and describes the type and condition of habitats in and adjacent to the land to be affected by the proposal.
4. Impacts & Mitigation Measures	Assesses impacts of the proposal on flora and fauna and discusses measures to minimise impacts.
5. Habitat Assessment	Assesses the value of vegetation communities occurring on the site.
6. Threatened Species Evaluation	An evaluation of the likelihood of threatened species occurring on the site.
7. Offsets	An outline of agreed offsets and mitigation measures including proposed size of offset area, vegetation type, and management actions in offset areas.
8. Conclusion	Discusses the results, including a summary of the information collected, and an outline of agreed mitigation measures and compensatory habitat offsets.
9. References	Cites publications used in the report
10. Appendices	Detailed information used in the report:
- Assessments of Significance	- assesses whether the proposal is likely to have a significant effect on threatened biodiversity under the TSC and EPBC Act
- Survey Data	- field survey species lists;
- Desktop search results	- NPWS Wildlife Atlas, Protected Matters Search Tool
- Additional information	- Other information and guidelines referred to in the report.

Abbreviations

ADC	Armidale Dumaresq Council
CAMBA	China-Australia Migratory Bird Agreement
CE	Critically Endangered
CERRA	Central Eastern Rainforest Reserves
DEC	Department of Environment and Conservation (historic)
DECC	Department of Environment and Climate Change (historic)
DECCW	Department of Environment, Climate Change and Water (current)
DEH	Department of the Environment and Heritage (historic)
DEWHA	Department of the Environment, Heritage, Water and the Arts (current)
DNR	Department of Natural Resources (not current)
DWE	Department of Water and Energy (current)
DoP	Department of Planning
EA	Environmental Assessment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act* 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
EPBC 2000	*Environmental Protection and Biodiversity Conservation Regulations* 2000
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NPWS	National Parks and Wildlife Service (now DECCW)
ROTAP	Rare or Threatened Australian Plant (after Briggs and Leigh 1996)
SEPP 44	State Environmental Planning Policy Number 44: Protection of Koala Habitat
SIS	Species Impact Statement
sp.	Species (singular)
spp.	Species (plural)
subsp.	subspecies
TSC Act	*Threatened Species Conservation Act* 1995
TSR	Travelling Stock Reserve
var.	variety

Definitions

***Abundance* –** means a quantification of the population of the species or community.

***Activity* -** has the same meaning as in the *Environmental Planning and Assessment Act 1979.*

Affected species – means subject species likely to be affected by the proposal.

Biodiversity values – composition, structure and function of ecosystems and includes (but is not limited to) threatened species, populations and ecological communities, and their habitats.

Conservation status – is regarded as the degree of representation for a species or community in formal conservation reserves.

***Development* -** has the same meaning as in the *Environmental Planning and Assessment Act 1979.*

Director-General – means the Director-General of the Department of Planning.

Groundwater dependent ecosystems are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.

***Locality* -** means the area within a 10 km radius of the study area.

***Offsets* -** agreed actions that are undertaken to counter-balance the adverse impacts of approved development. In relation to biodiversity, offset actions provide a mechanism to compensate for loss of biodiversity values in one area by action elsewhere

***Putrescible waste* -** general solid waste .that do not contain free liquid. (e.g. organic waste from household, council litter bins, manure, night soil, disposable nappies, incontinence pads, sanitary napkins, food waste, animal waste, dewatered grit or screenings from sewage treatment systems).

***Region* –** means the same meaning as that contained in the TSC Act, which is a bioregion defined in a national system of bioregionalisation.

Study area - is the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.

Subject site - means the area that is proposed for development/activity.

***Subject species* –** means those threatened and significant species, populations and ecological communities that are known or considered likely to occur in the study area.

***Threatening process* –** has the same meaning as that contained in the TSC Act; however is not limited to key threatening processes.

***Threatened species* –** For the purposes of this report the term ‘threatened species’ refers to species, populations and ecological communities listed in the TSC Act and EPBC Act.

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1. Introduction

E.A. Systems was engaged by AECOM on behalf of Armidale for Armidale Dumaresq Council to conduct a flora and fauna and habitat assessment of the proposed new regional putrescible landfill site, 12 km east of Armidale (Figures 1-3).

1.1 Legislative Context

The proposed new landfill development will be assessed under Part 3A of the NSW *Environmental Planning and Assessment Act* (EP&A Act 1979) for major infrastructure. The Environmental Assessment (EA) for the Armidale Regional Landfill is being prepared to comply with the original Director General's Requirements (DGRs) under Section 75 of the EP&A Act 1979 issued on the 25th October 2005 (DoP 2005) and the revised DGRs issued on the 20th November 2008 (DoP 2008). The revised DGRs set out a number of policies, guidelines and plans to be considered for the biodiversity assessment process:

- *Environmental Protection and Biodiversity Conservation Act 1999 – Guide to implementation in NSW* (DoP 2000);
- *Environmental Protection and Biodiversity Conservation Regulation 2000 Schedule 4* (Austlii 2000a);
- *Draft Guidelines for Threatened Species Assessment* (DEC 2004);
- *NSW Groundwater Dependent Ecosystem Policy* (DNR 2002);
- *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI 2003); and
- *State Environmental Planning Policy No. 44 – Koala Habitat Protectio*n (Austlii 2000b).

1.2 Aims and Objectives

The primary aims of the flora and fauna assessment study for the Armidale Regional Landfill proposal, as it relates to biodiversity assessment, were developed after consultation with the Department of Environment and Conservation (DEC now DECCW) following a planning focus meeting on 9th June 2005.

The five main aims of the biodiversity assessment are set out below:

1. Establish the area, character and conservation value of existing ecosystems and dependent species to be impacted either directly or indirectly by the proposal;
2. Consider the significance of all potential impacts in the regional context;
3. Provide detailed information regarding the measures required to minimize impacts to natural and biological values on the proposed landfill site;
4. Ensure that any revegetation activities to be undertaken on the site involve the use of locally prevalent species. Stock should be grown from seed collected on site or in the immediate vicinity of the site, in the case of species that may have occurred in vegetation communities found on the site; and
5. Provide as much initial detail as possible of the sort of compensatory offset area envisaged by the proponent. The final parameters and details of appropriate offset to be negotiated following discussion with DECC, the proponent and its consultants during the EA process.

The revised DGRs (DOP 2008) for the key issue of biodiversity include addressing:

- Impacts on threatened species, populations, and ecological communities and their habitats;
- Impacts on aquatic habitats and groundwater dependent ecosystems;

- Proposed biodiversity offsets and management; and
- Weed management, including potential risks to the Oxley Wild Rivers National Park.

In addition, the assessment considered the impact of the proposed development on matters of national environmental significance listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An assessment of potential Koala habitat was undertaken to satisfy the requirements for State Environmental Planning Policy (SEPP) 44 - Koala Habitat Protection.

In order to address these aims and objectives a desktop review and on-site field investigations were undertaken to assess direct and indirect impacts of the proposed landfill on threatened species and other significant biodiversity values.

The flora and fauna survey included:

- Baseline surveys of the site to detect species, populations and ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act* (EPBC Act); and
- Description of the types and conditions of habitats in and adjacent to the land to be affected by the proposal.

The flora and fauna assessment included:

- Preparation of a list of threatened species, populations or ecological communities, or their habitats, that may occur on the site;
- Application of the “Assessment of Significance” (seven part test), to any threatened species, populations or ecological communities found, or with potential habitat, on the study area, in accordance with *Draft Guidelines for Threatened Species Assessment* (DEC 2004), the *Threatened Species Assessment Guidelines* (DECC 2007) and the *Significant Impact Guidelines and Matters of National Significance* (DEH 2006b); and
- An assessment of the impact of the proposed development on matters of national environmental significance listed under the EPBC Act 1999.

The format for this assessment follows the suggested structure outlined in the working draft Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004).

1.3 Proposed Development

Armidale Dumaresq Council (ADC) is planning to construct a new regional putrescible landfill facility to replace the existing facility on Long Swamp Road, which is almost at capacity. The existing Waste Transfer Station at Long Swamp Road will continue to operate as the receiving and recycling station for the new facility. The new landfill will have the capacity to accept approximately 15,000 tonnes per annum of solid waste from the Armidale Dumaresq, Uralla, Walcha and Guyra Local Government Areas. The landfill will accept waste for approximately 50 years.

There will be no direct public access to the proposed new landfill site. Waste will continue to be received and processed at the existing waste transfer station on Long Swamp Road, with non-recyclable wastes being compacted and transported to the new facility.

The concept design of the landfill will be prepared in accordance with the DECCW Environmental Guidelines for Solid Waste Landfills (1996) and new guidelines on Waste Immobilisation (Waste Classification Guidelines 2008). A preliminary indicative concept layout of the facility is shown in Figure 3.

The estimated total area for the operational landfill site including buffers and access routes is approximately 86 hectares. The landfill will be developed in stages to minimise the area of land disturbed by land filling at any one time. The landfill will be divided into five cells which will each take approximately 10 years to fill with waste.

The following works will be undertaken as part of the initial construction phase of the landfill:

- Construction of the access road, to enable access to the site from Waterfall Way approximately 1 km south of the highway;
- Installation of services, such as power and communications;
- Construction of amenities such as a site office, toilets and shed;
- Construction of a temporary leachate pond, to allow for the storage of contaminated water;
- Construction of a temporary sedimentation pond, to prevent rainwater containing sediments from contaminating the surrounding environment, in particular the Gara River;
- Preparation of the first landfill cell; and
- Fencing, landscaping and planting of trees and shrubs.

During the operation of the landfill, the waste will be placed in layers and compacted to minimise the space used and to stabilise the landfill. The placement of waste will be monitored at all times to ensure that no liquid, hazardous or medical waste is placed in the landfill. At the end of each day, the waste will be covered by a layer of material to reduce pests and vermin, suppress odour, decrease litter being generated, minimise the risk of fire and reduce the amount of rain water contained in the landfill. A truck wheel wash will be installed to remove dirt from trucks before they leave the landfill site.

Prevention of water pollution is one of the key environmental goals of the proposed landfill. No contaminated water, such as water which has come into contact with waste (leachate), will be discharged to the surrounding environment. To prevent groundwater pollution a barrier system will be installed at the base of the landfill. Bunding will be used to prevent surface water from entering the landfill.

Leachate will be collected from the landfill and managed using a strategy which may include a combination of a) evaporation in the leachate pond; and b) re-injection into the landfill.

Once land filling of waste has ceased within each landfill cell, it will be closed and rehabilitated. The surface of the landfill will be covered by a capping layer, which will act to prevent rainwater from entering the landfill and control landfill odour and gas. The surface of the closed landfill will be rehabilitated and monitoring of the landfill will continue in accordance with conditions set by the DECCW. The landfill will involve the filling of part of a natural valley to form a final landform which blends in with the existing environment.

1.4 Location

The study area is located approximately 12 km east of the Armidale CBD along the Waterfall Way within the New England Tablelands Bioregion and in the Macleay River catchment. The study area consists of portions of two properties *Sherraloy* (approximately 33 ha) and *Edington* (approximately 310 ha) and a 30 ha portion of the Gara Travelling Stock Reserve (TSR). It is proposed to develop approximately 86 ha of the study area for the new landfill facility. Of these 86 ha, the footprint area of the landfill and associated infrastructure will occupy approximately 20 ha and the remaining area will be used as an offset area to mitigate the effects of the necessary clearing (see Offset Management Plan).

The approximate centre of the study area is located at E 30° 33' 30" and N 151°47' 30" (383400E 6619000N AGD 1966 AMG Zone 56J) on the Hillgrove 1:25,000 Topographic Map sheet 9236-1N (Figure 1). Summary details of the location of the study area are presented in Table 1.

Table 1. Study Area Details

Attribute	Description
Bioregion	New England Tablelands
Catchment	Northern Rivers (Gara and Macleay Rivers)
L.G.A	Armidale Dumaresq
Parish / County	Gara / Sandon
Property name, Lot and DP	'*Sherraloy*' Lot 2 DP 253346, Lot 1 DP 820271 '*Edington*' Lot 1 DP253346 '*Gara TSR*' Lots 7003 and 7004 DP 1060201
Zoning	Rural 1(A)

1.5 Local Context

The local context of the proposed new landfill site is presented in Figure 1 and Figure 2. The proposed landfill site is on portions of two rural holdings, *Sherraloy* and *Edington* that are primarily used for sheep and cattle production and is bounded on three sides by other rural properties and on the fourth (northern) side by the Gara TSR along Waterfall Way. The general area for the proposed footprint of the landfill site is located on the northern portion of *Sherraloy*, amongst a stand of Stringybark regrowth (Figure 3) and northwestern boundary of *Edington* through pasture. The proposed footprint is located approximately 1.0 km west of the Gara River, and approximately 4 km north-north-west (i.e. upstream) of the Oxley Wild Rivers National Park. The Oxley Wild Rivers National Park is listed on the Register of World Heritage sites. It is part of the Gondwana Rainforests of Australia NSW CERRA (Central Eastern Rainforest Reserves Hastings-Macleay group) in recognition of the extensive dry rainforest that occurs within gorges in the park. The gorge country and associated habitats support a high level of biodiversity that includes many threatened or rare species of plants and animals.

1.6 Site History

The properties of *Sherraloy* and *Edington* are used primarily as grazing enterprises. Both properties have been substantially cleared for grazing apart from a patch of Stringybark Woodland that occupies the northern section of *Sherraloy* and extends east into *Edington*. Dead timber from past thinning of the Stringybark Woodland has been pushed into piles on *Sherraloy.* Pasture on the study area is dominated by native grasses. There has been some pasture improvement on the land around the dams which has been sown to clover.

The portion of the Gara TSR between the old highway and the re-alignment of Waterfall Way is a well vegetated roadside strip. Since early last century (and possibly earlier) this land has been reserved for travelling stock and has been protected from severe forms of disturbance such as broadscale clearing and set stocking rates. It has been subject to occasional grazing by travelling domestic stock but remains relatively undisturbed. The remains of the old highway road-base have been ripped a number of years ago and now support some regrowth of shrubs and herbs, but few trees. The vegetation community within the TSR is an excellent example of the endangered ecological community (EEC) listed under the TSC Act 1995 as *White Box-Yellow Box-Blakely's Red Gum Woodland (Box Gum Woodland)*. It is also listed as a critically endangered (CE) community *White Box-Yellow Box-Blakely's Red grassy woodland and derived native grasslands (Box Gum Woodland)* under the Commonwealth EPBC Act 1999.

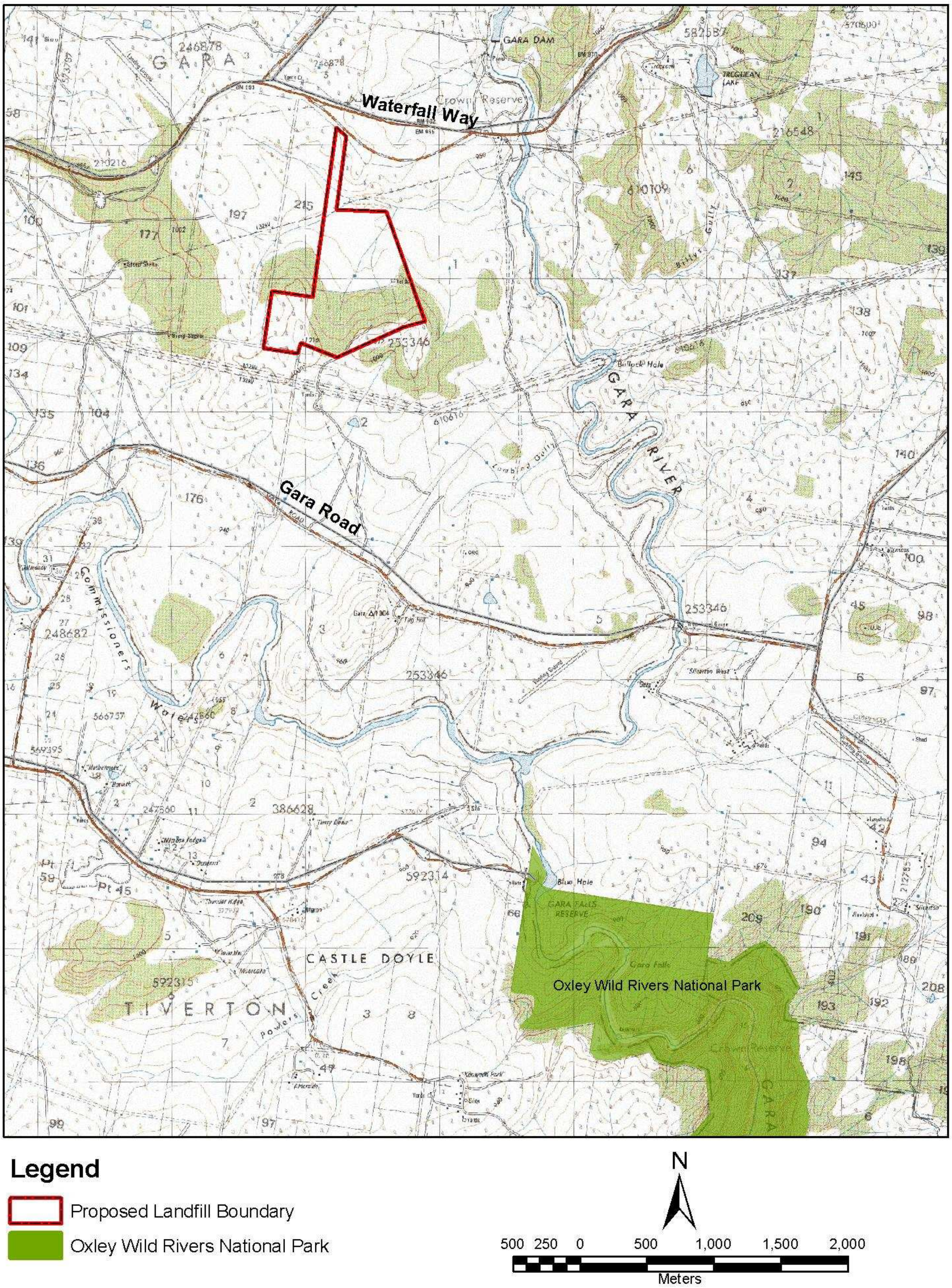

Figure 1. Location of proposed new landfill site showing Waterfall Way, Gara River and Oxley Wild Rivers National Park

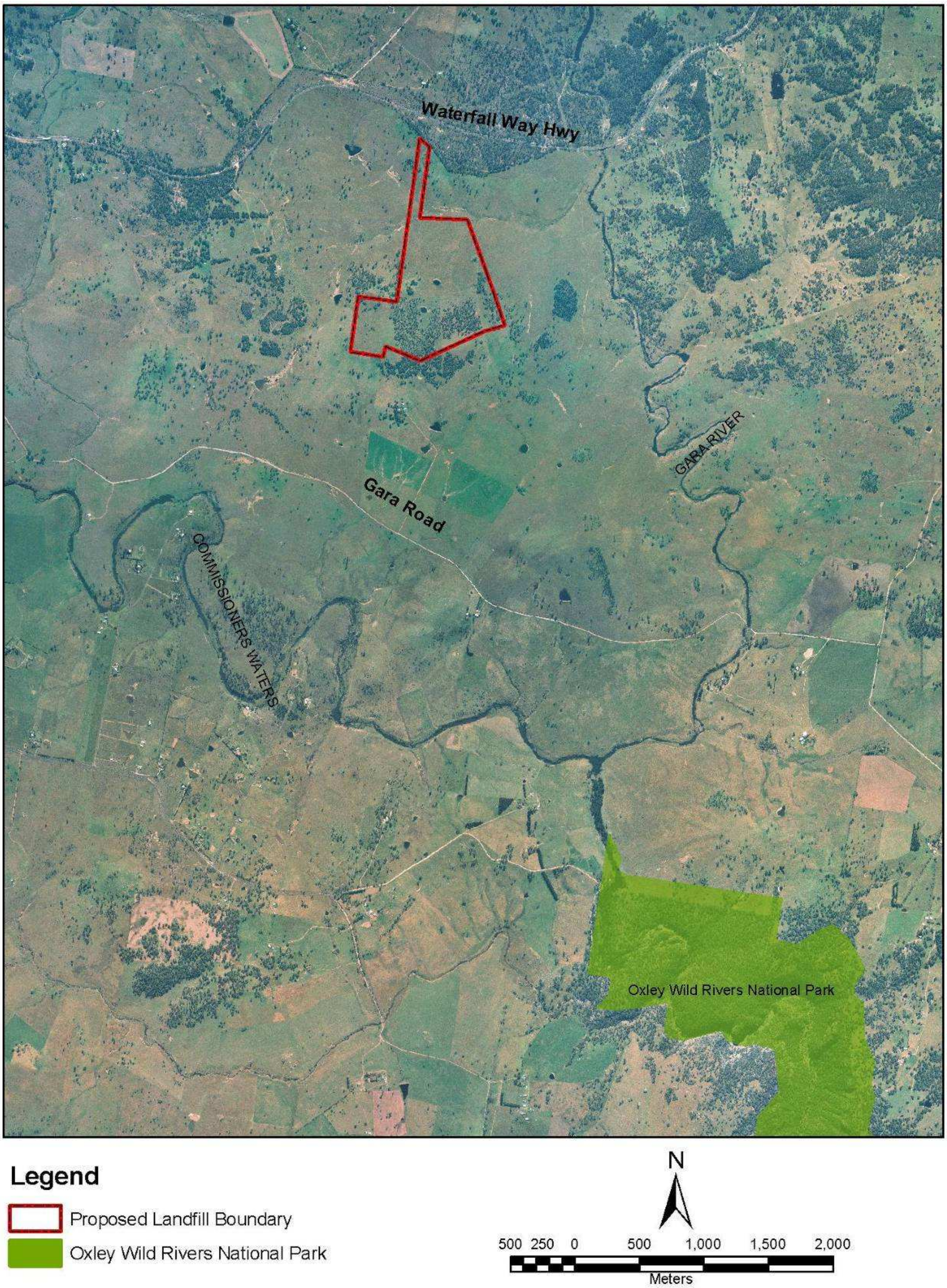

Figure 2. Aerial photograph showing the local context of the proposed new landfill site

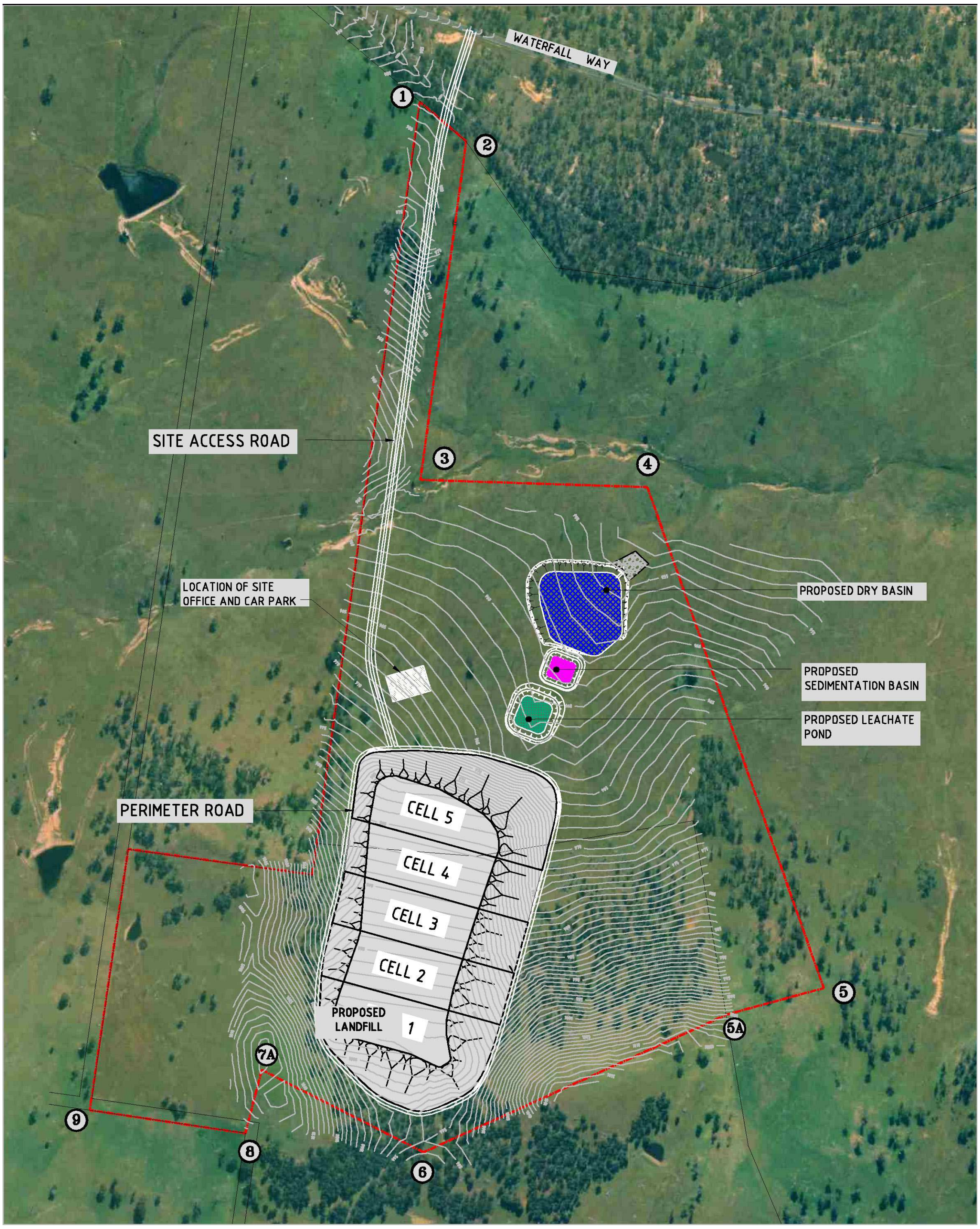

Figure 3. Indicative concept layout and landfill footprint of the proposed development (provided by AECOM)

1.7 Site Description

1.7.1 Landform

The study area spans a number of landforms. The Waterfall Way highway runs east-west and down an east facing simple slope towards the Gara River. Access to the proposed landfill site will leave the Waterfall Way at some point mid slope, and cross a ridge top in the Gara TSR before descending down a simple slope to the south. At the base of this south facing slope are two gullies that merge to form a single, easterly flowing drainage that joins the Gara River approximately 1.0 km to the east. An area of flats extends to the south of these gullies for approximately 500 m before rising into a north facing slope. The footprint of the proposed void and fill area for the landfill is likely to primarily occupy the mid to upper reaches of the north facing slope.

The study area ranges between 950 and 1,020 m above sea level. The gradient of the south facing slope down which the access route must pass ranges from 6% to 21%. The gradient across the gullies and flats (measured in a downstream direction to the junction with the Gara River) is between 1 and 2%. The gradient of the north facing slope upon which the actual landfill operational area will potentially be placed is approximately 11%. The proposed location of the landfill area is likely to be placed in the upper part of the slope. This will minimise the volume of run-on that may otherwise flow onto the landfill operational area. Local relief and contour heights in the vicinity are shown in Figure 1.

1.7.2 Climate

Climate data have been obtained from the Bureau of Meteorology (Armidale Airport: Station No. 562238; and University of New England: Station No. 056037).

- Average annual rainfall is 832 mm per annum.
- Mean monthly minimum temperatures range from 0.5°C (July) to 14°C (June).
- Mean monthly maximum temperatures range from 13°C (July) to 27°C (January).
- Average number of frost days is 97 per annum.

1.7.3 Hydrology

The Gara River flows from north to south along the eastern boundary of *Edington*. The river frontage extends approximately 2,500 m along the property boundary. The minimum distance between the Gara River and the potential site footprint for the landfill is 1,060 m.

Two intermittent drainage lines flow onto *Edington* from the western neighbouring property *Strathaven*. These drainage lines flow onto the site from westerly and south westerly directions for approximately 300 m before they merge to form a single gully that intermittently flows east a further 1,300 m across *Edington* until it joins the Gara River at the north-western corner of the property.

Seven small farm dams are scattered across *Sherraloy*, and two small farm dams are present on *Edington*. The preliminary footprint area for the landfill and associated buffers contains two of these dams.

The Gara catchment is a major catchment in the local area. The Gara River runs into the Macleay River that eventually reaches the ocean at Trial Bay near South West Rocks and Kempsey in northern NSW. The mid and lower reaches of the Gara and Macleay rivers are characterised by deep and extensive gorge systems that form part of the Oxley Wild Rivers National Park and the Central Eastern Rainforest Reserves World Heritage Area. The Gara River descends into a gorge approximately 4.3 km south-south-east of the landfill site in Oxley Wild Rivers National Park. The distance along the riverbed between the closest point to the landfill site and the Oxley Wild Rivers National Park is 8.8 km. Commissioners Waters flows into the Gara River from the east at a point 800 metres upstream of the Oxley Wild Rivers National Park (Figure 2).

1.7.4 Geology and Soils

The most recent and comprehensive soil survey of the area is that undertaken by the Department of Natural Resources and is currently in draft copy by King, D.P. (in prep 2006), Soil Landscapes of the Armidale 1:100 000 Sheet Report, Department of Natural Resources, Sydney. The proposed landfill site occurs predominantly within two soil landscape groups; *Argyle* and *Middle Earth*. A small section of the site, located along the drainage gullies, is classified as *Commissioners Waters*. A description of the soil types present on the study area is given in Appendix K.

1.7.5 Vegetation

The vegetation survey identified five distinct communities on the study area, as shown in Figure 4.

Community 1 –Stringybark Woodland advanced regrowth

This partially cleared woodland occurs in the southern section of the site and is dominated by re-growth New England Stringybark (*Eucalyptus caliginosa*) and occasional Yellow Box (*E. melliodora*). Most of the trees are less than 16 m high and less than 50 cm diameter at breast height (DBH) The shrub layer is sparse and despite heavy grazing, the ground layer is relatively diverse with a number of native grasses and herbaceous species (Plates 1 and 2). This Stringybark community is common and widespread in the New England region, although endemic to the region.

Community 2 – Cleared grasslands

Cleared grassland occurs in the northern half of the proposed development dominated by native grasses such as Slender Rats Tail Grass (*Sporobolus creber*), Blown Grass (*Lachnagrostis avenaceus*), Red-Leg Grass (*Bothriochloa macra*), Couch (*Cynodon dactylon*) and Small Lovegrass (*Eragrostis leptostachya*) (Plates 3 and 4). This community is common and widespread on private land, but generally in a heavily grazed condition.

Community 3 – Sedgeland

Sedgelands occupy the shallow drainage lines running through the grassland. This community is dominated by Tall Sedge (*Carex appressa*), Umbrella Sedge (*Cyperus eragrostis*), Paspalum (*Paspalum dilatatum*) and Pinrush (*Juncus usitatus*). The sedgeland intergrades with the grassland forming areas of grassy sedgeland on the lower lying land (Plates 5 and 6). This community is common and widespread in low-lying damp areas, but on private land is generally in a heavily grazed condition.

Community 4 – Wetland (dams)

The farm dams on the site support an artificial assemblage of wetland plants. Around the waters edge are moisture loving species such as Tall Sedge, Umbrella Sedge, Water Couch (*Paspalum distichum*) and Spreading Knotweed (*Persicaria prostrata*), while in the water itself are Ribbonweed (*Vallisneria gigantea*) and Swamp Lily (*Ottelia ovalifolia*) (Plates 7 and 8).

Community 5 Box Gum Woodland

Box Gum Woodland occurs on the Gara TSR that adjoins the northern boundary of Edington. This community is classed as an EEC under the TSC Act 1995 (*White Box-Yellow Box-Blakely's Red Gum Woodland)*. It also meets the definition of the EPBC Act listed CE Box Gum Woodland community.

Vegetation on the Gara TSR is in good condition with many species sensitive to grazing pressure present which were absent from the grazed blocks. The TSR vegetation consists of New England Stringybark (*Eucalyptus caliginosa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), Apple-Topped Box (*E. bridgesiana*), Bendemeer White Gum (*E. elliptica*) and Narrow-Leaved Black Peppermint (*E. nicholli*). The shrub layer is mostly sparse with occasional plants of Spiny Parrot Pea (*Dillwynia sieberi*), Chinese Lespedeza *(Lespedeza juncea*) and Peach Heath (*Lissanthe strigosa*). The ground layer is dominated by native grasses such as Kangaroo Grass (*Themeda australis*) (Plates 9 and 10).

1.7.6 Disturbance History

The site has been disturbed by clearing, grazing, weed invasion and the impact of introduced animals, particularly Rabbits, which were present in the southern section of the site in very high numbers.

Apart from the area within the TSR, the site has been completely cleared over time, with some areas returning to advanced regrowth of New England Stringybark and Yellow Box. On *Sherraloy*, and *Edington*, 83% of the land is cleared pasture and 17% supports patches of light to medium dense woodland. A few large Blakely's Red Gum (*Eucalyptus blakelyi*) trees remain in the south west corner of *Edington*, but these trees are in generally poor health, showing evidence of dieback, and do not appear to provide high habitat value. There are some standing stags across the cleared areas of the site. By contrast, vegetation on the TSR appears to be relatively intact and disturbance from clearing is minimal. However, a small area of the eastern section of the TSR has been partially cleared and appears to be a disused access area. Other recurring disturbance factors observed in the TSR during the field surveys include dumping of rubbish (building materials, etc), removal of dead wood for firewood collection, and cutting of green timber for fence posts.

A total 28 introduced plant species were recorded on pasture and partially cleared woodlands on *Sherraloy* and *Edington*. More than half (16) of these species were also recorded on the TSR. The majority of the study area was showing impacts from heavy grazing at the time of the survey, with many bare and eroded areas scattered amongst the grassland. The pasture remains mostly native and reasonably diverse. There has been some pasture improvement around the dams with clover sown a few years ago. The grassland areas of *Edington* have historically been treated with super-phosphate fertilizer, but this has not occurred on *Sherraloy*. Grazing impacts from domestic stock were notably absent from the TSR section of the study area.

Felled timber in the Stringybark Woodland on *Sherraloy* in the southern section of the study area had been pushed up into piles between 10 and 20 years ago (see Plate 2). The density of log piles in the Stringybark Woodland ranged from 11 to 17 piles per hectare. These log piles were providing refuge to an extremely high population of Rabbits. Rabbits are likely to contribute significantly to the heavy grazing pressure being experienced on the study area. Fox numbers are likely to be high as a result of the abundant Rabbit population. A number of log piles are also infested with large Blackberry bushes.

1.7.7 Habitat Overview

The overall habitat value of the site is moderate. The habitat value of the TSR is high while the habitat value of the grazed areas of *Edington* and *Sherraloy* is low to moderate. The ground cover had a moderate diversity of species, however it had been heavily grazed and there was an almost complete lack of shrub cover. Little surface biomass remains as habitat for native fauna species. Parts of the study area have comparatively good tree cover, however diversity of tree species is low, consisting mainly of fragmented stands of advanced New England Stringybark regrowth. The wooded area is utilised by two species of threatened woodland birds, the

Speckled Warbler (*Pyrrolaemus saggitata*) and the Diamond Firetail Finch (*Stagonopleura guttata*). A Little Eagle nest was also observed in the Stringybark Woodland.

The wooded area of the subject site also contains numerous log piles resulting from clearing 10 and 20 years ago (Plate 2). Although these log piles provide potential habitat for ground dwelling native fauna, particularly reptiles, they also provide shelter for high densities of Rabbits, Foxes, feral Cats and Blackberries.

There are few hollow bearing trees on the subject site (not including the TSR) but some isolated living and dead trees containing hollows remain in parts of the cleared area of the grazed site. Scattered rock outcrops occur on the northern portion of the grazed area. There are two small intermittent water courses entering the site from the west that converge to form a gully that flows to the east until it joins the Gara River. The gully has generally low habitat value due to the paucity of riparian vegetation and lack of permanent pools of water. Dams provide permanent – semipermanent water however the lack of fringe vegetation and impacts of grazing and trampling up to the water's edge reduce their habitat value.

On the TSR, mature trees, some bearing hollows and a healthy shrub and understorey are present. The area contains scattered rock outcrops that are likely to provide habitat for reptiles. Beside the old portion of the highway and along some of the dirt tracks in the TSR there is a scattering of debris and rubbish such as old tiles and tins that are also likely to provide habitat for ground dwelling fauna.

1.7.8 Habitat Connectivity

The study area is located 5.5 km east-north-east of the Imbota Nature Reserve, 4.2 km south-east of the Yina Nature Reserve, and 4 km north-north west of Oxley Wild Rivers National Park. The land between the study site and these nature reserves and the national park is largely cleared and used for grazing livestock, however there are scattered fragments and patches of woodland that, taken together, form a network of connectivity. Some of these fragments are visible in the aerial photo shown in Figure 2.

Species that require continuous forested areas are likely to disappear from areas that are severely fragmented. These isolated remnants of woodland provide potential habitat to enhance connectivity of wildlife populations and help some species to overcome the consequences of habitat fragmentation (Wilson & Lindenmayer 1995). Thus every patch of woodland in this area potentially plays an important role in facilitating dissemination of propagules and genetic material of native fauna and flora that helps to maintain viable populations within the local area.

The study area is close to two major corridors (Figure 5) identified by the NPWS Key Habitat and Corridor mapping project (NPWS 2006). The "Gara Remnant Sub-regional Corridor" that links Gara River and Midas Gully passes 2.7 km to the east of the study area. The "Mt Killalee Regional Corridor" that links Booroolong Nature Reserve and Tilbuster Ponds passes 7.6 km to the north-west of the study area. The area of Box Gum Woodland in the TSR beside Waterfall Way is identified as "key habitat" by the NPWS Key Habitat and Corridor mapping project.

The fragments of Stringybark Woodland on the southern section of the study area form part of an intermittent east-west band of similar woodland patches in the local area. The nearest sizable remnants of woodland are located 350 m to the east, and 350 m to the west of woodland patches on the study area. The Box Gum Woodland on the northern part of the study area is located approximately 900 m north of the Stringybark fragments. The nearest woodlands south of the site, not within the subject site, include narrow riparian woodland along parts of the Gara River and Commissioners Waters. These patches of woodland may provide potential habitat to enhance connectivity of wildlife populations in the local area and possibly connecting to Oxley Wild Rivers National Park 4.3 km to the south of the study area.

Low woodland of New England Stringybark (*E. caliginosa*) and Bendemeer White Gum (*E. elliptica*) is recognised as a significant community in the Oxley Wild Rivers National Park management plan. Bendemeer White Gum is locally abundant in parts of the Northern Tablelands but restricted to higher altitudes. Both New England Stringybark and Bendemeer White Gum occur on the TSR in the study area. No Bendemeer White Gum was recorded in the Stringybark Woodland in the southern section of the study area. New England Stringybark and Bendemeer White Gum occurring in the study area may contribute to genetic diversity to this significant community via habitat corridor linkages to similar communities in Oxley Wild Rivers National Park.

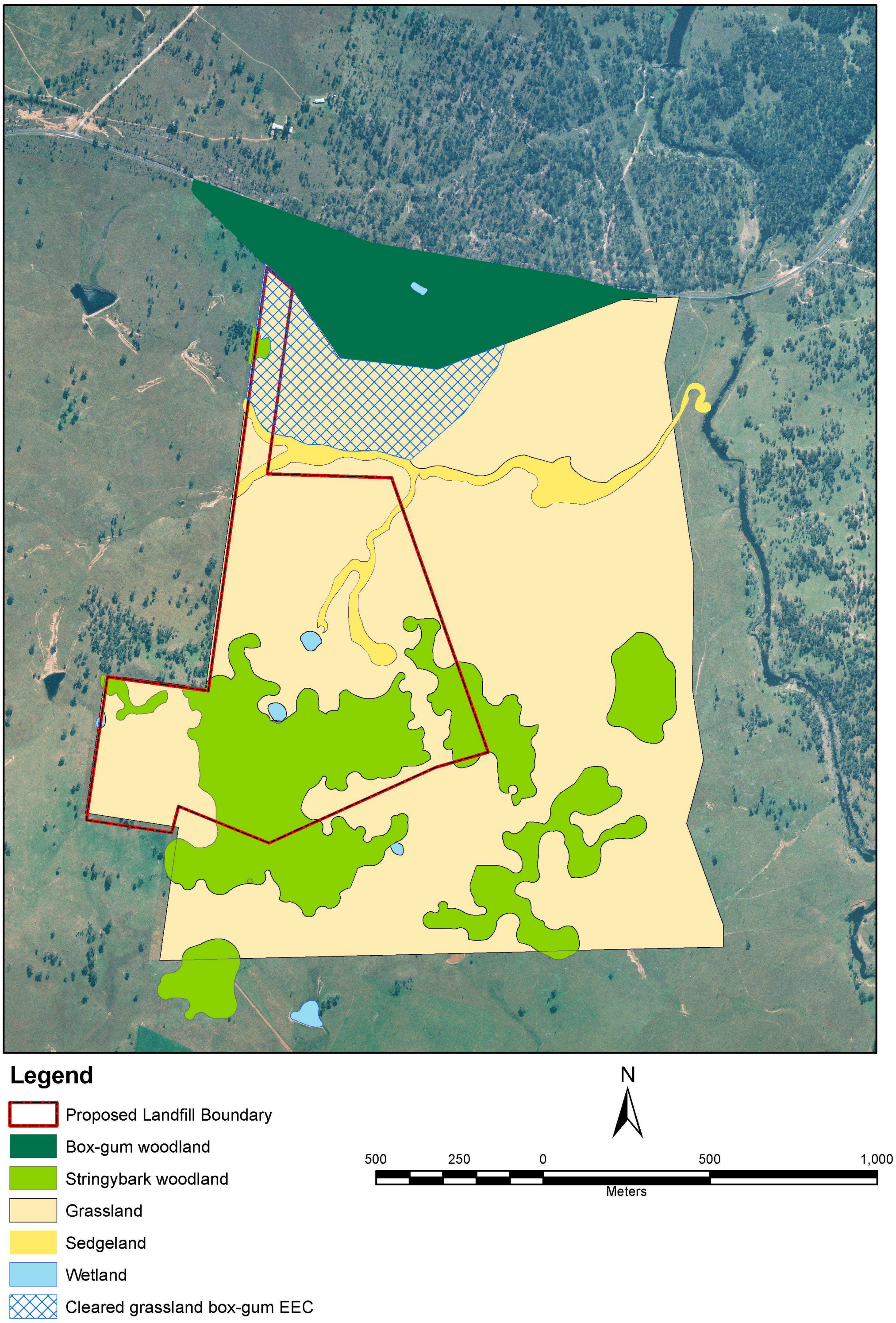

Figure 4. Vegetation communities on the proposed landfill site

Plate 1. Community 1 – Stringybark Woodland – grassland interface

Plate 2. Community 1 – Stringybark Woodland – showing pushed up log piles

Plate 3. Community 2 – Cleared grassland – isolated stag and paddock trees in distance

Plate 4. Community 2 – Cleared grassland – with isolated paddock tree

Plate 5. Community 3 – Sedgeland – close up view

Plate 6. Community 3 – Sedgeland – darker patches in mid-ground

Plate 7. Community 4 – Wetlands – farm dam with stock trampled edges

Plate 8. Community 4 – Wetlands – farm dam in low lying grassy-sedgeland

Plate 9. Community 5 – Box Gum Woodland – low regrowth on old Grafton Way road base in foreground

Plate 10. Community 5 – Box Gum Woodland left of fence, cleared grassland right of fence

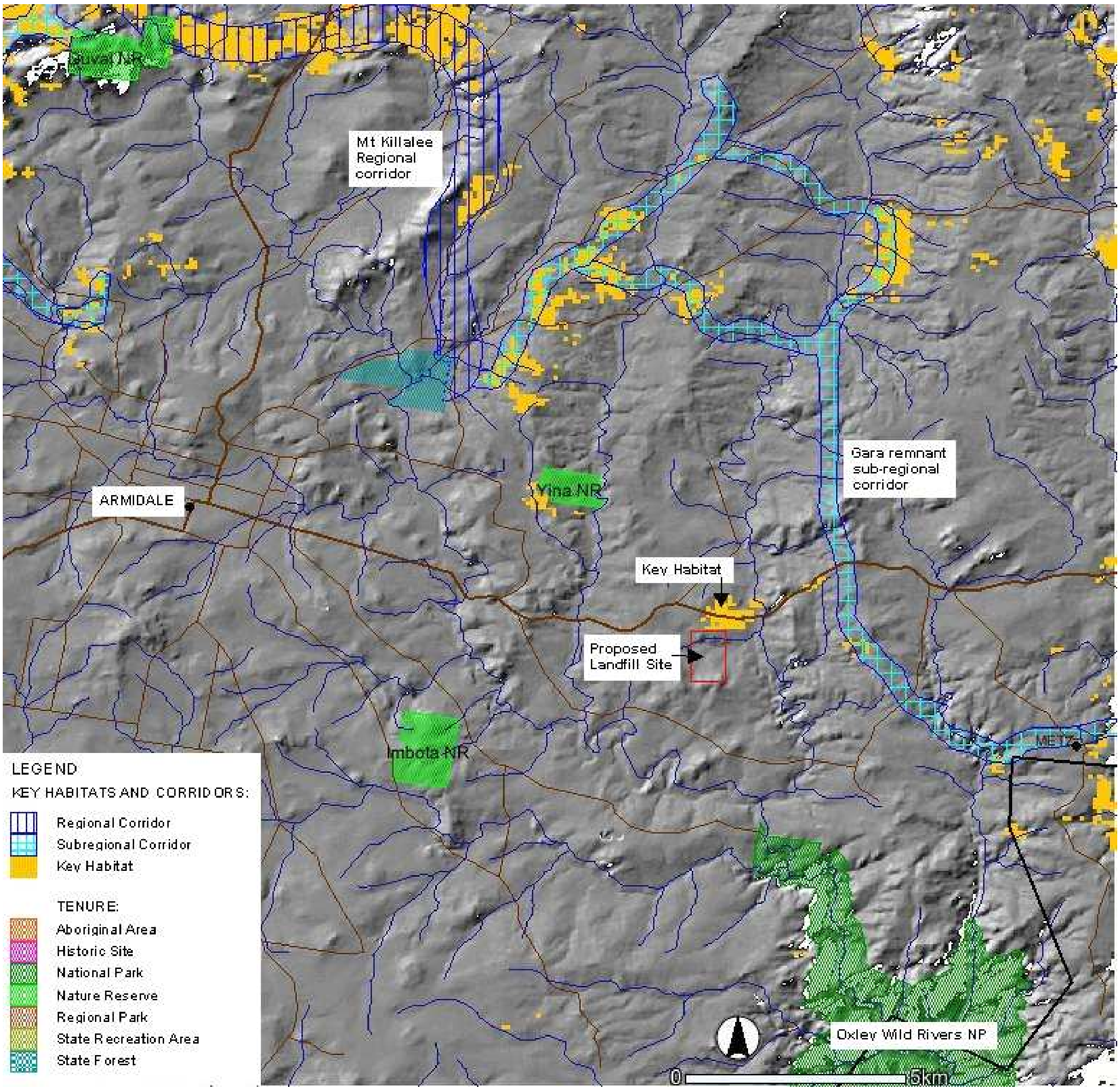

Figure 5. NPWS key habitats and corridors east of Armidale

2. Methods

In order to assess the impacts of the proposed landfill biodiversity values in the local area a desktop database review and field investigations were undertaken on the subject site.

2.1 Information Sources

Records of flora and fauna within 20 km of the study area were obtained from the National Parks and Wildlife Service (NPWS) Wildlife Atlas to determine if any threatened species had been recorded at the study area or in a similar habitat in the district (http://wildlifeatlas.nationalparks.nsw.gov.au/) (Appendix G).

The EPBC Protected Matters Search Tool was also accessed to determine if any Matters of National Environmental Significance are likely to occur within a 20 km radius of the study area (http://www.deh.gov.au/erin/ert/epbc/index.html) (Appendix H).

A list of birds previously recorded in the adjacent Gara TSR north of the Waterfall Way was obtained from Birds Australia (Appendix F).

The list rare or threatened Australian plants (ROTAP species: Briggs & Leigh 1996) was consulted, to identify any plant species that may be locally significant, although not necessarily listed as threatened under the relevant legislation.

2.2 Field Investigations

Desktop review of topographic maps and aerial photographs was used to help determine stratification units for the field surveys. Stratification units for this study corresponded with vegetation communities on the subject site, Figure 4). The intensity of survey effort was tailored to the size and complexity of each stratification unit. Field surveys were conducted in seasons which are appropriate for detecting the majority of taxa.

The purpose of field investigations were to systematically survey the study area and to fill in any information gaps identified from the preliminary desktop investigations. The field surveys were designed to target threatened biodiversity which may occur in the area, to identify potential habitat for these species, and to determine the likelihood of their presence and how the proposal will impact upon them.

2.3 Flora

The site was surveyed for flora in autumn and in spring in 2005. Dr Lachlan Copeland and Ms Sally Egan completed the autumn flora survey on 3 April 2005 and Dr Lachlan Copeland completed the spring flora survey on 15 October 2005. On each occasion an assessment of vegetation communities and significant flora species was conducted using a Random Meander search (Cropper 1993).

The purpose of the flora surveys was to:

- Obtain an understanding of the plant communities in the survey area and identify community boundaries;
- Define community structure;
- List the species present on the site;
- Identify the potential distribution of threatened plants and record inconspicuous species; and
- Obtain opportunistic flora records.

An additional survey in September 2006 was undertaken by Dr Elizabeth Broese to assess the current condition of the areas proposed for clearing activities for the landfill development. This survey entailed (20 x 50) nested quadrats consistent with the *Native Vegetation Regulation 2005*, Environmental Outcomes Assessment Methodology (DNR 2005) and random meander targeted searches for threatened species.

A number of condition variables were recorded to assess current site condition of remnant woodland areas that are proposed to be cleared, i.e., the TSR access route, Waterfall Way turning lane for the landfill access and the landfill operational area. These variables included native plant species, native over-storey cover, native mid-storey cover, native ground cover (grasses), native ground cover (shrubs), native ground cover (other), exotic plant cover, number of trees with hollows, overstorey regeneration, and length of fallen logs.

2.4 Fauna

Fauna surveys were carried out in autumn and spring 2005 to record fauna present on the proposed landfill site and the adjacent TSR. The autumn survey was completed by Dr Stephen Debus, Mr Martin Dillon, and Ms Sally Egan on 29th and 30th March 2005 and the spring survey was completed by Dr Stephen Debus, Mr Martin Dillon and Ms Sarah-Jane Hackett on 18th and 19th October 2005. An additional survey in September 2006 was undertaken by Dr Stephen Debus and Mr Martin Dillon to assess the impact of the proposed access route through the TSR. This survey included an intensive search for evidence of Koala utilisation in a 3 ha area around the proposed access route. A final follow-up survey of the landfill site and TSR was undertaken on 23-24 November 2009 by Dr Stephen Debus and Dr Lisa Doucette. This survey was to search for potentially threatened birds for which a preliminary determination was pending under the TSC Act. A diurnal (including a search for scats and scratches) and nocturnal Koala survey (spotlighting) in the TSR and at the landfill site was also undertaken.

Diurnal birds were surveyed visually and aurally by habitat search. Searches for reptiles and signs of presence of fauna species involved scanning of trees and logs, searching under rocks, litter and logs, and inspection of tree cavities and hollow stumps. Reptiles and frogs were identified with reference to Cogger (2000) and Swan (1990). Searches for mammals included visual scans, diurnal searches for scats and tracks, and nocturnal spotlighting.

A search for nocturnal fauna was conducted by 2-3 observers on 5 nights. On each night a megaphone was used to playback calls of masked and barking Owls in the Box Gum Woodland and beside the Stringybark Woodland community. Hand held 100 watt spotlights (‘Clulite’, Cluson Engineering) were used on foot for spotlight searches of nocturnal mammals and birds. Frogs were identified from their calls with reference to Stewart (1998). An ultrasonic bat detector (‘Anabat’ Titley Electronics) was used to record bat calls onto a Compact Flash memory card. Identification of bat calls was determined by using ANALOOK 4.9j software (Corben 2004) with reference to Pennay *et al*. (2004) and Reinhold *et al*. (2001). Call identification is based on the following levels of confidence: (C) – Confident, (P) – Probable. Bat taxonomic nomenclature and common names follow those of Churchill (1998).

Survey conditions were generally conducive to good quality results during the survey period. Weather conditions and total survey effort are presented in Table 2. A total of 119.6 person hours was spent surveying for fauna and 37 person hours was spent surveying flora on the site.

Pitfall or Elliott trapping for mammals was not conducted. This was on the basis that previous extensive trapping in similar or better habitat remnants in the Armidale area has detected only introduced rodents but no native terestrial small mammals (Debus *et al.* unpublished data). Additionally no threatened reptiles or frogs occur in the local area (Debus *et al.* unpublished data).

Table 2. Flora and Fauna Survey Effort and Weather Conditions

Date	**Task**	**Time**	**Person Hours (no. people x hrs)**	**Weather**
29 March 2005	Diurnal fauna survey Nocturnal fauna survey	0930-1830 1830-2000	3 x 9 = 27 2 x 1.5 = 3	Cloud 3/8 Light E to SE wind. Max Temp ~ 23^{o}C
30 March 2005	Diurnal fauna survey Nocturnal fauna survey	0800-1500 1730-1830 1830-2000	3 x 8 = 24 2 x 1.5 = 3	Cloud 3/8 Light E to SE wind. Max Temp ~ 23^{o}C
3 April 2005	Flora survey	0900 - 1700	2 x 9 = 18	Cloud 1/8 Moderate WSW wind Max Temp ~ 24^{o}C
15 October 2005	Flora survey	0900 - 1700	1 x 9 = 9	Cloud 8/8 Moderate E wind Max Temp ~ 20^{o}C
18 October 2005	Diurnal fauna survey	0740-1400	2 x 9 = 18	Cloud 7/8 Light E wind. Max Temp ~ 17^{o}C
19 October 2005	Nocturnal fauna survey	1815-2215	3 x 4 = 12	Cloud 3/8 Light E wind. Max Temp ~ 14^{o}C
18 September 2006	Flora survey Diurnal fauna survey Nocturnal fauna survey	0730-1830 0700-1500 1730-1830 1815-2215	1 x 10 = 10 1 x 8 = 8 2 x 4 = 8	Cloud 1/8 Light E to SE wind. Max Temp ~ 23^{o}C
23 November 2009	Diurnal fauna survey	0625-0915 (landfill), 0925-1045 (TSR)	2 x 3 = 6 2 x 1.3 = 2.6	Cloud 0/8 No wind Max Temp ~ 30°C
24 November 2009	Diurnal fauna survey Nocturnal fauna survey (spotlighting)	1715-1825 (TSR) 18:30-20:20 (landfill) 20:35-21:45 (TSR)	2 x 1 = 2 2 x 3 = 6	Cloud 1/8 Light-moderate N wind Max Temp ~20°C

3. Survey Results

3.1 Limitations of the Survey

The main limitation of the survey was its ‘snapshot’ nature meaning that only a proportion of the full species diversity was likely to be detected.

The weather conditions for most of each survey period were considered conducive to good quality results. These weather conditions were generally light to moderate winds, partially cloudy skies, and mild temperatures (Table 2). The seasonal conditions for the flora surveys were considered conducive to moderate quality results in autumn and very good quality results in spring. The seasonal conditions for the fauna survey were considered conducive to good quality results on all survey dates. The lack of trapping was unlikely to limit the results for native mammals (see Section 2.4).

3.2 Flora

The flora surveys recorded 180 species, including 11 trees, 29 shrubs (3 exotic), 3 climbers/vines, 2 mistletoes, 35 grasses (7 exotic), 98 herbs (24 exotic) and 2 aquatic plants (Appendix C). One threatened flora species was recorded on the study area: Narrow-Leaved Black Peppermint (*Eucalyptus nicholii).* This species is listed as vulnerable under both the NSW TSC Act and the Commonwealth EPBC Act. One Rare or Threatened Australian Plant (ROTAP Briggs and Leigh 1996) species, Bendemeer white gum, *E. elliptica* was recorded. It is locally and regionally significant, although not subject to legal provisions under the TSC or EPBC Acts.

Five vegetation communities occur on the study area: Stringybark Woodland, Box Gum Woodland, cleared grassland, sedgeland and wetland. The distribution of these communities is presented in Figure 4. Photos of each community are presented in Plates 1 to 10.

Community 1 - Stringybark Woodland

This partially cleared woodland community occurs in the southern section of the site and is dominated by re-grown New England Stringybark (*Eucalyptus caliginosa*) and occasional Yellow Box (*E. melliodora*). Isolated individuals of Fern-Leaved Wattle (*Acacia filicifolia*) and Black She-Oak (*Allocasuarina littoralis*) occur sparsely. Blakely’s Red Gum (*E. blakelyi*) are found rarely in some fragments. Trees are generally spaced from 4-20 m apart. There are very few fully mature trees, and hollows and den sites suitable for arboreal mammals and bats are rare. Overall the diversity of tree species in this community is poor. A significant feature present within the site is numerous log piles that have been pushed together following clearing 10 to 20 years ago. These log piles occur at a density of 11-17 piles per hectare (Plate 2).

The shrub layer is sparse with widely scattered individuals of three main species: Blackthorn (*Bursaria spinosa*), Peach Heath (*Lissanthe strigosa*) and Guinea Flower (*Hibbertia linearis*) and rare or sporadic occurrence of individuals of a further 13 species listed in Appendix C. Exotic shrubs were also occasionally present including Hawthorn (*Crataegus monogyna*), Blackberry (*Rubus fruticosus* complex) and Sweet Briar (*Rosa rubiginosa*).

The grass layer is moderately diverse with a number of native grasses and occasional herbs scattered throughout the woodland despite heavy grazing. The most common grasses include Slender Rat’s Tail Grass (*Sporobolus creber*), Red-Leg Grass (*Bothriochloa macra*), Rough Speargrass (*Austrostipa scabra*), Couch (*Cynodon dactylon*), Snow Grass (*Poa sieberiana*), Small Lovegrass (*Eragrostis leptostachya*), Purple Wiregrass (*Aristida ramosa*) and Slender Wallaby Grass (*Austrodanthonia racemosa*). Growing amongst these grasses are herbaceous species such as native Stinging Nettle (*Urtica incisa*), Slender Sedge (*Cyperus gracilis*), Pin Rush (*Juncus usitatus*), exotic Stinging Nettle (*Urtica urens*) and native Burr-Daisy (*Calotis cuneifolia*). Burr-Daisy is the only herb to occur in any great abundance and this daisy appears to be particularly resilient to the heavy grazing regime.

The Stringybark Woodland community occurs in a series of irregular shaped patches on the study area. The smallest of these are clumps of a few trees that occupy less than 0.02 hectares (200 square metres) while the largest contiguous patch is 32 ha in area (see Figure 4). The total area of this community within the area surveyed is 62.8 ha. This community occupies 17% of the surveyed area. The patches are predominantly surrounded by cleared grassland, but never-the-less form part of an intermittent band of woodland patches within the local region that is likely to be a relatively significant corridor for fauna and flora.

The Stringybark Woodland community is widespread in the region surrounding the proposed landfill site, albeit in fragmented and dispersed patches. The Stringybark Woodland community on the study area falls within the category of “New England Grassy Woodlands” defined by Keith (2004). Between 60 and 90% of grassy woodlands on the Northern Tablelands have been cleared since European settlement (Keith, 2004). The overall habitat value of the Stringybark Woodland community is considered to be moderate. The proposed development will require an access easement through a portion of the Gara TSR that lies between the Waterfall Way and the northern boundary of Edington. Approximately 25% of the Stringybark Woodland within the subject land will be cleared for the landfill site, but this is a negligible proportion (less than 1%) of that available in the region.

Community 2 – Cleared grasslands

Cleared grassland occupies 212.6 ha or 68% of the flora survey within the study area and occurs in the northern half of the proposed development area. Historically, this community was woodland prior to clearing for pasture establishment over the last 100 years. It has been almost completely cleared and only isolated individual trees are scattered in the northern and southern parts of the grassland community, particularly close to the Stringybark Woodland patches in the south, and close to the Box Gum Woodland in the northern part of the study area. There are also dead tree stags still standing in some areas. There is no evidence of any recent regeneration of trees or shrubs. It has been intensively grazed by sheep and cattle and generally has low habitat quality.

The cleared grassland community is dominated by native grasses such as Slender Rats Tail Grass (*Sporobolus creber*), Blown Grass (*Lachnagrostis avenaceus*), Red-Leg Grass (*Bothriochloa macra*), Couch (*Cynodon dactylon*) and Small Lovegrass (*Eragrostis leptostachya*) as well as exotic grass species like Pale Pigeon Grass (*Setaria pumila*) and Paspalum (*Paspalum dilatatum*). Pinrush (*Juncus usitatus*) and the exotic weed Spear Thistle (*Cirsium vulgare*) are common in the grassland. Shrubs are mostly absent, apart from occasional exotic Hawthorn (*Crataegus monogyna*) and Sweet Briar (*Rosa rubiginosa*).

Even though the tree cover has been mostly removed (more than 30 years ago), a high proportion of this grassland community meets the definition as the Box Gum Woodland EEC. The cleared grasslands do not have sufficient non-grass native understorey species to qualify for inclusion under the EPBC Act, but does qualify under the broader description of the TSC Act (Appendix J). The proposed development will require an access route through the grassland community that will occupy approximately 3.3 ha.

The exotic grasses potentially occupy a high proportion (50% or greater) of grass cover in low-lying areas adjoining the sedgeland. Approximately 25% of the grassland community within the subject land will be cleared for the landfill site, but this is a negligible proportion (less than 1%) of that available in the region.

Community 3 – Sedgeland

Sedgelands occupy the shallow drainage lines running through the grassland. This community is dominated by Tall Sedge (*Carex appressa*), Umbrella Sedge (*Cyperus eragrostis*, exotic), Paspalum (*Paspalum dilatatum*, exotic) and Pinrush (*Juncus usitatus*). Trees and shrubs are absent from this community. The division between sedgeland and grassland is not always distinct. Sedgeland and grassland intergrade to form grassy sedgeland on low lying parts of the study area.

Sedgeland occupies 9.43 ha or 3% of the flora survey area. The sedgeland community has been heavily grazed by sheep and cattle and generally has low to moderate habitat quality. The exotic grasses and sedges potentially occupy a high proportion (50% or greater) of cover in the sedgeland. Approximately 50% of the sedgeland community within the subject land will be cleared for the landfill site, but this is a negligible proportion (less than 1%) of that available in the region.

Community 4 – Wetland (dams)

The farm dams on the site support a small assemblage of wetland plants. Around the waters edge are moisture loving species such as Tall Sedge, Umbrella Sedge, Water Couch (*Paspalum distichum*) and Spreading Knotweed (*Persicaria prostrata*) while in the water itself are Ribbonweed (*Vallisneria gigantea*) and Swamp Lily (*Ottelia ovalifolia*).

The total area of farm dams on the site is 0.6 ha. The edges of the farm dams in the proposed footprint area have been subject to pugging (trampling by domestic livestock) and the habitat quality is low to moderate.

Community 5 Box Gum Woodland

Box Gum Woodland occurs on the portion of the Gara TSR that lies between the Waterfall Way highway and the northern boundary of *Edington.* This community is classed as the Box Gum Woodland EEC under the TSC Act and Critically Endangered EC under the EPBC Act (Appendix J). The proposed development will require an access easement through this community across the narrowest, most degraded and westerly part of the TSR. Approximately 2 ha will be affected, in an area where the woodland is already partly cleared and open, with mostly young Stringybark trees. Less than 5% of the relevant part of the TSR (south of Waterfall way) is affected, a negliglible proportion (less than 1%) of that available in the local area.

The dominant trees in this community are New England Stringybark (*E. caliginosa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), Apple-Topped Box (*E. bridgesiana*), Bendemeer White Gum (*E. elliptica*) and a small population of Narrow-Leaved Black Peppermint (*E. nicholli*). Trees are generally spaced from 6 to 20 m apart. Both mature and juvenile trees are common, and hollows and denning sites suitable for arboreal mammals and bats are abundant.

Narrow-Leaved Black Peppermint is listed under Schedule 2 (vulnerable) of the TSC Act and as vulnerable under the EPBC Act. The small population of this species consisting of six adults and five juvenile trees was found within 40 m of the corner post of the far north-western tip of the proposed development area (Figure 6). Narrow-Leaved Black Peppermint is endemic to the Northern Tablelands of NSW where it occurs from Niangala in the south to Glen Innes in the north (Williams 1992; Brooker & Kleinig 1999; Hill 2002). A large population is reserved close to its western limit in Single National Park (30 km north-west of Guyra) while another significant population is known to occur 10 km east of the study area along the Waterfall Way. The Wildlife Atlas records this species from 2 to 10 km east of the site along Waterfall Way. This species is not located within the parts of the site identified for clearing.

Bendemeer White Gum was found near the southern boundary fence of the TSR (Figure 6). Bendemeer White Gum is a rare species (ROTAP) on the Northern Tablelands, but is not listed under the TSC or EPBC Act. This species is scattered over the southern part of the Northern Tablelands (e.g. Walcha, Bendemeer and Wollomombi districts). It prefers grassy woodland on sandy soils, and is known to occur 22 km east of the study area along the Waterfall Way. This species is not located within the parts of the site identified for clearing.

The shrub layer is mostly sparse with occasional plants of Spiny Parrot Pea (*Dillwynia sieberi*), Chinese Lespedeza (*Lespedeza juncea*) and Peach Heath (*Lissanthe strigosa*). Thes are relatively common species in the better woodland remnants around Armdiale.

The ground layer is dominated by native grasses such as Kangaroo Grass (*Themeda australis*), Snow Grass (*Poa sieberiana*), Slender Wallaby Grass (*Austrodanthonia racemosa var. racemosa)* and Native Sorghum (*Sarga leiocladum*). Two of these species (Kangaroo Grass and Native Sorghum) were rare to absent from the heavily grazed block to the south, indicating a disturbed understorey. These native grasses are not listed under the TSC or EPBC Acts.

Vegetation in the Box Gum Woodland is in good condition with many species that are sensitive to grazing pressure present. These species were absent from the grazed blocks in the other communities on the study area. A total of 140 different native species were recorded in the Box Gum Woodland community (Appendix C). The Box Gum Woodland community occurs as a single patch occupying 29.6 ha or 9.4% of the flora survey area (see Figure 4). The community is contiguous with a larger patch of woodland in the main part of the Gara TSR on the northern side of the Waterfall Way.

Box Gum Woodland communities are widespread in the region surrounding the proposed landfill site, albeit in fragmented and scattered patches. The Box Gum Woodland community on the study area falls within the category of *New England Grassy Woodlands* defined by Keith (2004). Between 60 and 90% of grassy woodlands on the Northern Tablelands have been cleared since European settlement (Keith, 2004). The overall habitat value of the Box Gum Woodland community on the study area is considered to be high.

3.3 Condition of Proposed Clearing Areas

The condition of all the remnant woodland survey quadrats, as assessed during the field flora surveys, was moderate to good with little bare soil observed, and there was natural regeneration of all overstorey eucalypts and a diverse native understorey present (Table 3). The proposed Waterfall Way turning lane (landfill access route) had the highest proportion of weedy exotic species, reflecting the disturbed roadside verge vegetation. The survey quadrats within the propsed TSR access route, which is currently partly cleared and open, had a higher percentage of ground cover (due to the increased light availability in cleared areas) and lower percentage of overstorey cover than the adjoining TSR survey quadrats. The project will not require the whole of the TSR to be cleared, and the TSR as a whole is in better condition than the small part within the proposed access route. The Stringybark Woodland had higher overstorey cover and more fallen logs than the Box Gum Woodland remnants.

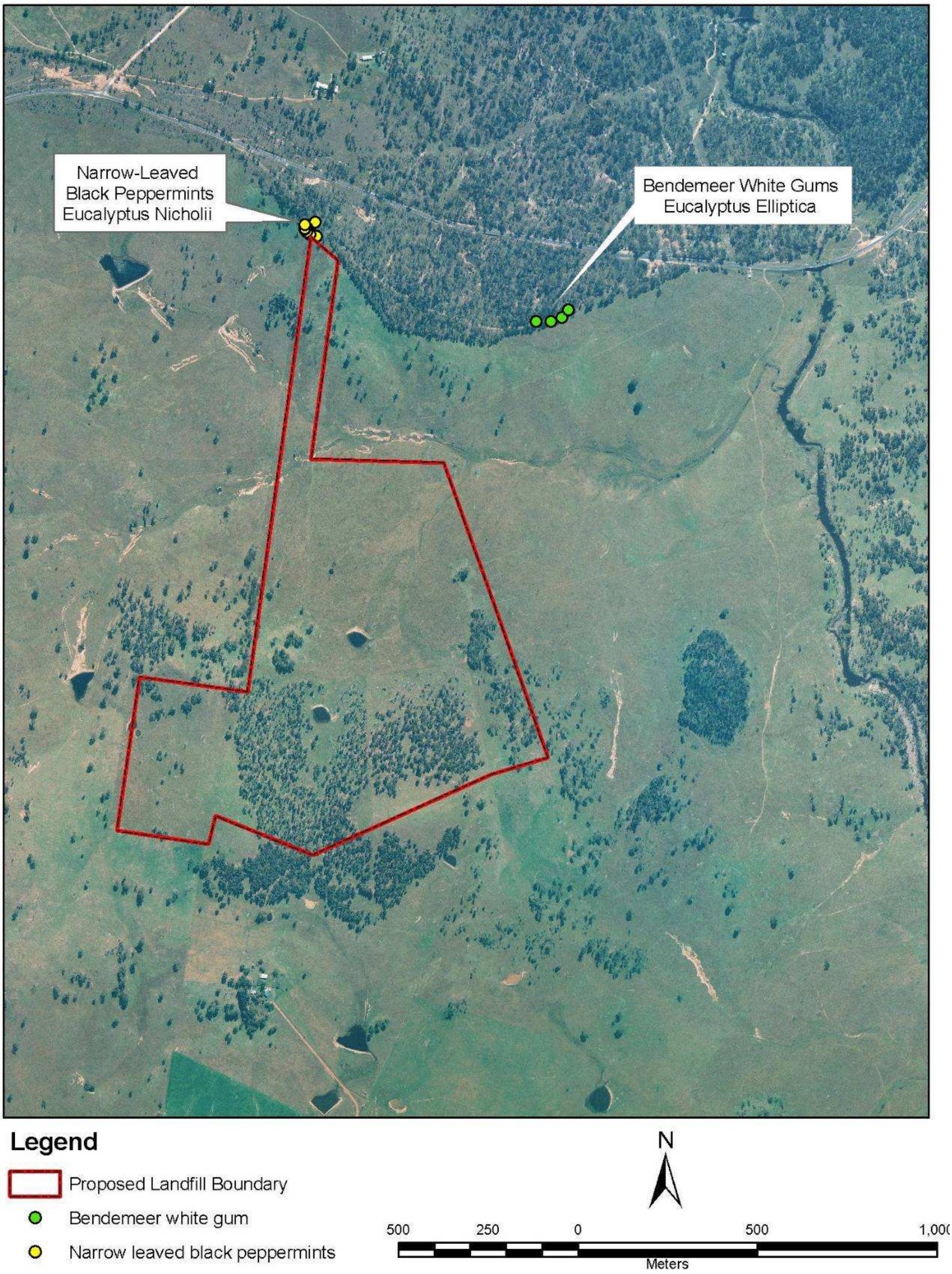

Figure 6. Map showing locations of observed threatened flora species

Table 3. Quadrat Survey. Site condition (20 x 50 m plot) 18 September 2006

Variable	**TSR 1**		**TSR 2**		**TSR_A 1**		**TSR_A 2**		**WFW**		**StrBk 1**		**StrBk 2**	
	%Cover	**No spp**	**%Cover**	**No spp**	**%Cover**	**No spp**	**%Cover**	**No spp**	**%Cover**	**No spp**	**%Cover**	**No spp**	**%Cover**	**No spp**
Native overstorey cover	11	**4**	12	**3**	6	**4**	0	**3**	8	**2**	16		30	**1**
Native mid-storey cover	0		2	**1**	0	**2**	0	**2**	0	**1**	0		2	**1**
Native ground cover shrubs <1m	4	**5**	2	**7**		**6**		**3**		**2**	2	**2**	0	
Native ground cover (grasses)	54	**3**	42	**7**	44	**3**	60	**5**	38	**8**	30	**8**	12	**6**
Native ground cover (other)	2	**12**	2	**20**	2	**18**	2	**21**		**18**	4	**11**	4	**12**
Exotic cover (ground)	2	**3**	2	**2**		**3**		**5**		**11**		**2**		
Exotic cover (shrub)				**2**										
Number of trees with hollows	2		1		0		0				0		0	
Regeneration	yes		yes		yes		yes		yes		yes		yes	
Total length of fallen logs	16		25		0		5		3		20		40	
Total species (20x50m)		**36**		**32**		**36**		**39**		**42**		**23**		**22**

TSR – Travelling Stock Reserve 50 m from access route; TSR_A1&2 – TSR access route; WFW – Waterfall Way turning lane; StrBk - Stringybark Woodland

3.4 Fauna

3.4.1 Birds

The assessment of the study area identified 80 bird species (1 exotic), as shown in Table D1, Appendix D. Two threatened bird species, Speckled Warbler *Pyhrrolaemus* (now *Chthonicol*a) *sagittata* and Diamond Firetail *Stagonopleura guttata* (TSC Act - Vulnerable), were detected on the study area in both the TSR beside Waterfall Way and in the Stringybark Woodland. These species were identified within the proposed development area (Figure 7). Three bird species currently the subject of a Preliminary Determination to list them as threatened (TSC Act – Vulnerable) were also detected, in both the TSR and in the Stringybark Woodland in the proposed development area (Appendix D; Figure 7): the Little Eagle *Hieraaetus morphnoides*, Scarlet Robin *Petroica boodang* and Varied Sittella *Daphoenositta chrysoptera*.

3.4.2 Mammals

The fauna survey recorded 15 species of mammals of which 4 were exotic (Appendix D). Two threatened mammal species were detected on the study area: A single Koala (TSC Act – Vulnerable) was observed in the Box Gum Woodland in the TSR beside Waterfall Way in 2005. Scats and scratches made by a Koala were recorded in the Stringybark Woodland at the landfill site in 2009. Eastern Bent-Wing Bat (TSC Act - Vulnerable) echo-location calls were recorded using an Anabat bat detector in the Stringybark Woodland in 2005.

The parameters used to assign bat calls to particular species using ANALOOK software (Corben 2004) are presented in Appendix D. The frequency vs. time graphs for all microbat species identified using ANALOOK software are presented in Appendix E.

Although, not threatened the Common Brushtail Possum (*Trichosurus vulpecular*) was very abundant in the Box Gum Woodland on the TSR. Eighteen (18) individuals, including two with young were recorded on the night of 24 November alone. Monitoring of tree removal to relocate disturbed individuals during tree felling for the access road should be undertaken.

3.4.3 Amphibians

Eight (8) species of frogs were recorded on the site (Appendix D). No threatened frogs were detected on the study area.

3.4.4 Reptiles

Ten (10) species of reptiles observed on the site (Appendix D). No threatened reptiles were detected on the study area

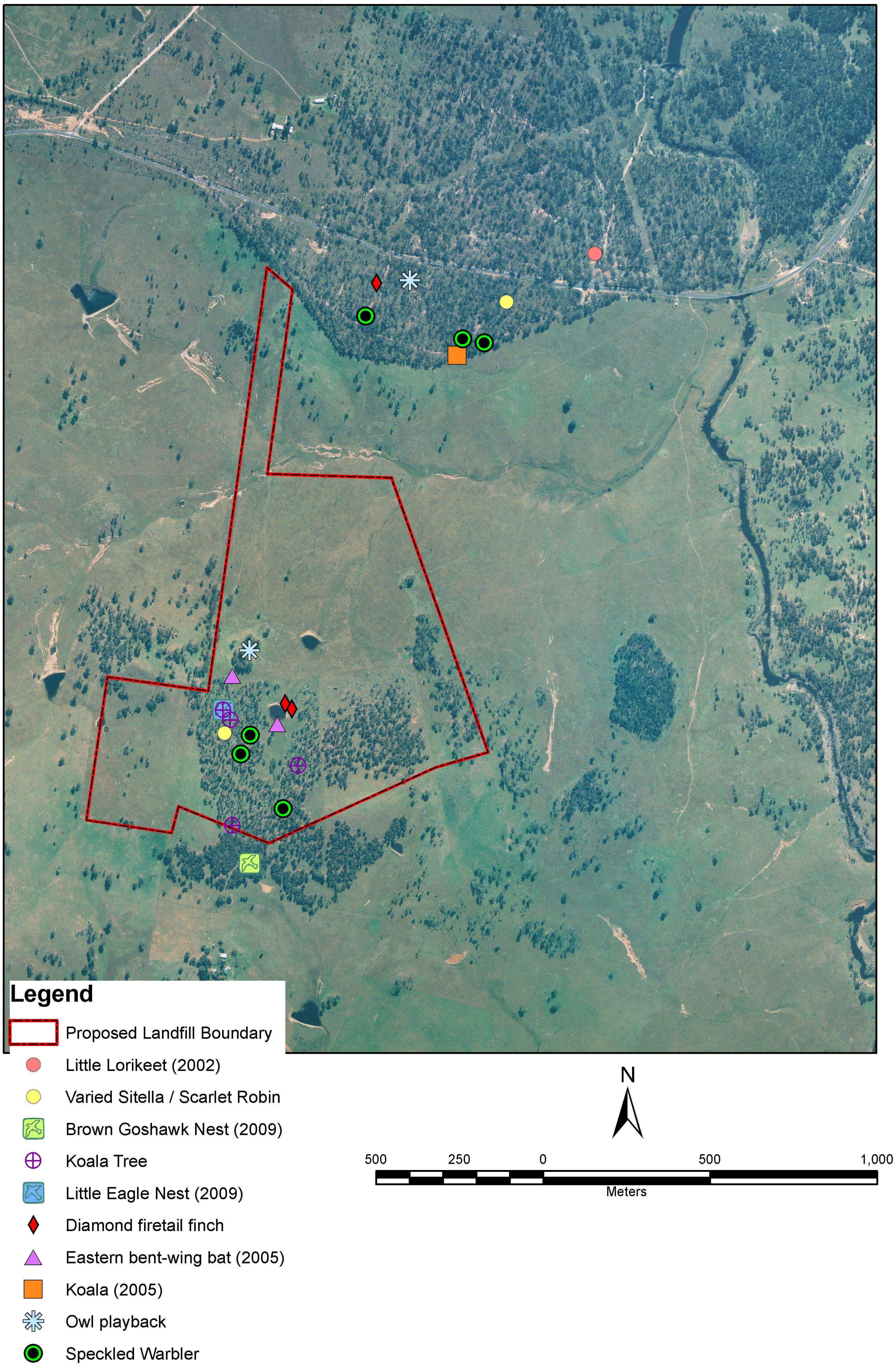

Figure 7. Map showing locations of observed threatened fauna species and the locations for owl call playback

4. Impacts and Mitigations Measures

Potential impacts of the proposal on native flora and fauna were considered in relation to direct and indirect impacts, the sensitivity of the environment and, the nature, extent, frequency, duration and timing of their effects.

Apart from continuing agricultural practices in the locality of the landfill site, it is unlikely that there will be any other developments, activities or actions that could contribute to cumulative impacts during the operational lifetime of the landfill since the proposed landfill site is 12 km from urban development in the rural zone.

The aim of the proposed mitigation measures is to avoid or ameliorate potential adverse impacts of the proposal on threatened biodiversity. Progressive rehabilitation of the landfill site will aim to recreate a landscape that is compatible with the surrounding land which is likely to be suitable for agricultural use.

4.1 Potential Impacts of the Proposed Development

In relation to native flora and fauna, the adverse impacts that may result from clearing, construction, and operation of a landfill include vegetation clearance, loss of habitat, weed invasion, increased competition and predation from feral animals and vermin, increased dust and noise levels, increased traffic hazards, and risk of pollution. Such disturbances reduce the habitat quality of the affected land and may threaten viable populations of threatened species found in the subject site.

4.1.1 Habitat loss

Impact:

Impacts to biodiversity resulting from the landfill development will span time scales that are at least inter-generational, if not permanent. The losses that will occur at the landfill site also contribute to the already significant level of cumulative habitat loss that has occurred at a regional scale on the New England Tablelands (DEC 2006).

The proposed action will involve clearing which will result in a reduction in the area of woodland and grassland habitat that supports native flora and fauna, including five threatened species, one ROTAP species and one EEC. Hollow-bearing trees will be lost in the Box Gum Woodland in the TSR.

Mitigation measures:

Clearing will be progressive, with landfill cells 4 and 5 not cleared for use for 30 to 40 years. Spent cells within the landfill pit will be progressively rehabilitated to stabilise soils and restore the landscape to a form that is compatible with the surrounding land and comparable to pre-existing land use. The first step in rehabilitation will be earthworks to create geomorphologically stable landscapes. The area over the landfill will be rehabilitated in a manner suitable for agricultural purposes.

Vegetation / Rehabilitation Management Plan: The vegetation management plan will include revegetation and landscaping works during construction, operation and post operation of the landfill site. The plan will also include details of actions to assist natural regeneration in areas where viable natural seed bank is likely to exist (such as areas where on-site stored topsoil is used for rehabilitation works). This plan should provide for.

- Minimising the extent of clearing: clearing should be undertaken in a staged process consistent with operational requirements;
- Avoiding clearing areas not immediately required for operational purposes;
- Fencing to exclude stock and Rabbits from regeneration and revegetation areas;
- Planting for landscaping and vegetated buffers using locally occurring native species. These areas should be established and planted as early as possible in the construction phase;
- The maintenance of adequate ground cover on all parts of the landfill site not required for day-to-day operations;
- Tube stock planting/direct seeding undertaken following autumn rains;
- Progressive rehabilitation and revegetation of spent landfill areas;
- Revegetation along fringes of proposed water storages (sedimentation and leachate ponds) to encourage use by native mammal, reptile, amphibian and bird species;
- Ongoing monitoring of condition of native vegetation in areas likely to be impacted by the proposed development including revegetated areas such as pit rehabilitation works, landscaping, vegetated buffers and other native vegetation communities occurring on the subject site;
- If understorey response is minimal, apply assisted rehabilitation (selected replanting of shrubs and seeding if feasible) especially in treeless areas; and
- Ongoing monitoring and follow-up control of weeds and pests that establish on disturbed areas, with particular attention to the eradication of noxious weeds and pests identified as Key Threatening Processes such as Rabbits and Foxes (Section 6.8).

Compensatory Habitat Offset Plan: Offsetting is a means by which the biological shortfall between a rehabilitated (stabilised) landscape and a pre-disturbance landscape can be narrowed. Actions to remove threats or ‘enhance’ biodiversity at another site are taken to compensate for loss of biodiversity values in the landfill site and the cumulative loss at regional scale (DEC 2006).

It is proposed to set aside an area of Stringybark Woodland and native grassland adjacent to the proposed landfill operational area to offset the area lost to development (see Offset Management Plan). The Stringybark Woodland and grassland offset areas are three times that proposed to be cleared for the landfill. Management of the offset area will be adaptive (i.e., the response of flora and fauna to management actions will be monitored and reviewed every 5 years).

Actions will include:

- fencing to exclude stock and Rabbits;
- revegetation to fill gaps;
- managed beneficial clearing to thin dense regrowth in accordance with DECCW guidelines for thinning regrowth (See Offset Management Plan);
- relocation of logs;
- weed and pest animal control; and,
- Ongoing maintenance and monitoring.

These actions should be implemented immediately once the land is purchased to minimise ecological risks from time lags.

Understorey response to grazing removal should be monitored from the outset. If understorey response is minimal, apply assisted regeneration (revegetate with local provenance tree and shrubs seedlings) especially in treeless areas. Growth and stand structure response should be monitored to assess the response of the understorey to thinning (see Offset Management Plan).

4.1.2 Impacts on aquatic habitats and groundwater dependant ecosystems (GWDE)

Clearing Impact:

Two small farm dams and a small area of sedgeland will be incorporated into the proposed landfill pit area and downstream sedimentation pond, leachate pond and dry basin resulting in a loss of approximately 0.5 ha of wetland (dams) and sedgeland. The wetland and sedgeland that is proposed to be lost to the development is currently in poor condition due to impacts of cattle pugging and grazing.

During the field assessment of the study site in 2005 no significant flora or fauna were observed in the two small farm dams within the development footprint area. 9.4 ha of sedgeland lays immediately downstream of the proposed new landfill footprint area. This sedgeland is confined to the shallow drainage lines that carry surface flows of water from the study area towards the Gara River 1 km to the east. The hydrological studies accompanying the Environmental Assessment indicate that there are no perched water tables in the study area. No groundwater dependent ecosystems have been identified in the study area, nor in the Oxley Wild Rivers National Park downstream of the proposed new landfill (DNR 2002). Thus, the proposed new landfill is not likely to have any impacts on groundwater dependant ecosystems, either in the study area or further downstream in Oxley Wild Rivers National Park.

Water Quality Impacts:

Changes to the amount and quality of drainage into the Gara River via the drainage channels running in an easterly direction along the northern section of *Edington* are dealt with in the Armidale Regional Landfill Environmental Assessment (AECOM 2010).

4.1.3 Vegetation Clearing and Relocation of Log Piles

Impact:

The proposal will involve clearing of less than 1 ha of native vegetation in the Gara TSR for a single access easement. The vegetation to be cleared in the Gara TSR is part of the EEC Box Gum Woodland.

The proposal will involve clearing 12.7 ha of the regrowth Stringybark Woodland community. This clearing will also involve the relocation of previously felled regrowth that has been pushed into numerous log piles (about 10 years ago).

Hollow-bearing stags in the grassland and hollow-bearing trees from Stringybark Woodland in the landfill area will be relocated to offset areas as logs or erect as stags if feasible in line with DECCW recommendations.

The access route through the cleared grassland and sedgeland will clear approximately 3.3 ha of ground cover.

Mitigation measures:

Vegetation Clearing Protocol and Native Fauna Management Plan: Preparation and implementation of a vegetation clearing protocol and fauna management plan to minimise negative impacts of vegetation clearing and log pile dispersal on threatened species and other locally significant native fauna. An ecologist should be present to monitor clearing operations.

The *vegetation clearing protocol* should address the following:

- Pre-clearing collection of locally sourced seeds for direct seeding and/or propagation of tube stock;
- The extent of clearing should be minimised, and undertaken in a staged process consistent with operational requirements;
- Clearly mark areas occupied by *Eucalyptus nicholii* and *E. elliptica* prior to any clearing or construction works. A minimum buffer of at least 30 m should be designated around these species and avoided during construction and operational phases;
- Identify and where possible avoid clearing 'habitat trees' that contain significant hollows likely to be used by native fauna (arboreal mammals, birds and bats);
- Where possible, retain dead trees and logs in the study area that have not been pushed into piles; and
- To minimise clearing of the Box Gum Woodland EEC it is recommended that the access road for the landfill site be located in the existing partially cleared area in the western part of the Gara TSR, where possible

The ***Native Fauna Management Plan*** should address the following issues in relation to clearing:

- Development of a protocol for responding to the detection of native fauna present in trees and log piles prior to clearing operations;

- Where practical, tree clearing and log-pile relocation should be restricted to late summer and autumn to avoid disturbing spring-breeding birds including the Little Eagle as well as species that nest in hollows, and over-wintering bats.

4.1.4 Fire

Impact:

Uncontrolled bushfire (originating off site, or by lightning strike in the offset areas) may result in temporary loss of habitat and thereby affect the viability of local populations of threatened species and the EEC occurring on the site.

Mitigation measures:

Fire Management Plan: Preparation and implementation of a fire management plan for the landfill site as well as surrounding bushland. This plan should provide for.

- Monitoring of fuel loads;
- Fuel reduction such as slashing, controlled grazing, and controlled burning where appropriate;
- A maintained perimeter firebreak between the landfill (external offset area boundaries) and all adjoining properties, to minimise bushfire hazard; and
- Hazard reduction burning in offset areas will not be permitted in line with DECC's requirements for offset areas.

4.1.5 Fragmentation, edge effects and reduced connectivity

Impact:

Clearing of parts of the Box Gum Woodland in the TSR and parts of the Stringybark Woodland will contribute to fragmentation of woodland habitat with associated edge effects and reduced connectivity.

Mitigation measures:

- Design layout of landscaping, vegetated buffers and other revegetation works to enhance connectivity between patches of remnant vegetation both within the landfill site (e.g. offset areas, access road verges) and between the offset areas and woodland patches on adjoining properties; and
- Progressive rehabilitation and revegetation of successively spent cells of the landfill, with shallow-rooted grasses, herbs and shrubs to provide some cover, to minimise the impact of fragmentation of Stringybark Woodland on the subject site.
- Allow and encourage, over time, the cleared native grassland to revert to Box Gum Woodland, with enhancement plantings of these tree species, to increase connectivity between the TRS and the landfill site.

4.1.6 Weeds

Impact:

Weed invasion may contribute to the loss of biodiversity through competition with native plants, and through provision of food resources and shelter for pest animal species. Woody weeds with fleshy fruit such as Hawthorn, pyracantha, and Blackberry encourage fruit eating birds that spread the seeds and may damage crops in the nearby olive grove on *Strathaven* (700 m to the west of the site) and to the Oxley Wild Rivers National Park (4 km to the south).

It is unlikely that weeds will be spread from landfill waste placed in the operational pit areas nor from rehabilitated pit areas in the future since green (garden) waste will be processed at the Long Swamp Road Waste Transfer Station. It is understood that Council does not intend to landfill any green waste at the proposed development site on Waterfall Way.

The potential introduction and spread of weeds from the landfill is more likely to be associated with soil disturbance and earthworks during the short term construction and rehabilitation phases of the landfill operation.

Mitigation measures:

Weed Management Plan: The preparation and implementation of an appropriate weed management plan for all stages of the development will help to minimise the spread of weeds within the landfill site and to adjacent areas of native vegetation. The plan will provide for:

- Control of existing weed infestations (in particular, Blackberry and Hawthorn) on the site prior to commencement of the construction phase;
- Strict enforcement of use of wheel wash facilities for all vehicles entering or leaving the site to prevent inadvertent transport of weed seeds attached to mud and or other plant material adhering to underside of vehicles;
- Targeted monitoring and weed control in areas subject to soil disturbance. In particular, control and monitoring of invasive exotic grasses, such as Coolatai grass, African lovegrass, Serrated tussock, and Chilean needlegrass which may spread from the Waterfall Way access route to the new landfill site;
- Stockpiling of local topsoil and mulch during construction of the landfill site in areas already cleared of vegetation for use in landscaping and rehabilitation works;
- Limiting the importation of topsoil, conducting appropriate investigations of potential topsoil sources and subsequent monitoring of any topsoil stockpiles topsoil to reduce the risk of introducing weed propagules;
- Minimising the use or impacts of herbicides; and
- Appropriate control of drainage and run-off that may spread weed seeds or high levels of nutrients.

4.1.7 Pest Animals

Impact:

The potential spread of pest animals such as Rabbits, Foxes, rodents, Cats, Starlings, Crows, Flies and Cockroaches from the landfill site may contribute to the loss of biodiversity through competition for resources and direct predation on native fauna. They may also reduce amenity of nearby residents and impact on agricultural production (eg olive grove 700 m west of the proposed new landfill site).

Mitigation measures:

Pest Management Plan: The preparation and implementation of an appropriate pest management plan for all stages of the development will help to minimise the spread of pests from the landfill site to adjacent areas.

- Appropriate fencing around the landfill;
- Initial poisoning (baiting) of Rabbits, Foxes and Cats over entire landfill area to reduce population densities prior to commencement of construction phase;
- Following protocols to protect native fauna outlined in the Native Fauna Management Plan, undertake initial relocation of all the logs in the log piles that provide shelter for Rabbits and Foxes as single dispersed logs (not log piles) within the Stringybark Woodland in the southern section of the study area prior to commencement of construction works;
- Minimise exposure of waste to pest species by covering it in a timely manner;
- Monitor and follow-up control of vertebrate (e.g. Rabbits and Foxes) and invertebrate pests (flies and insect pests which can infest olives, such as the olive lace bug *Froggattia olivinia* and black olive scale *Saissetia oleae)*; and
- Employ professional exterminators if an outbreak is detected.

4.1.8 Disease

Impact:

The potential spread of disease from the landfill operation that may contribute to the loss of biodiversity or agricultural productivity (e.g. exotic animal diseases like foot and mouth).

Mitigation measures:

Disease Monitoring Protocol: Preparation of a disease monitoring protocol and appropriate contingency plans to deal with outbreaks that may be detected at some point in time during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.

4.1.9 Increased abundance of undesirable native species

Impact:

An increase in aggressive native birds such as pied currawongs, magpies and noisy miners and carrion eaters such as crows and Australian ravens that may be displaced from the clearing activities for the landfill or that may be attracted to the site during the operation of the landfill.

Mitigation measures:

- The provision of areas for planting and rehabilitation using locally occurring native species particularly shrubs that will provide shelter for small native birds. These areas should be established and planted as early as possible in the construction phase; and,
- Control of exotic shrubs (e.g. Hawthorn) which provide food for aggressive native species.

4.1.10 Traffic

Impact:

Inappropriate traffic speeds increase the risk of collisions with wildlife and contribute to dust and noise levels.

Mitigation measures:

- Speed limits should be applied to roads associated with the landfill;
- Construct appropriate speed control structures on roads associated with the landfill, where practicable; and
- In areas of the Box Gum Woodland that has potential Koala habitat the speed limit should be low.

4.1.11 Dust

Impact:

Excessive dust may be deposited onto plants and reduce photosynthesis and respiration, thereby affecting plant health.

Mitigation measures:

Dust Management Plan: The preparation and implementation of an appropriate Dust Management Plan for all stages of the development.

4.1.12 Noise

Impact:

Excessive noise may disturb native fauna and disrupt their feeding and breeding.

Mitigation measures:

Noise Abatement Plan: The preparation and implementation of an appropriate Noise Abatement Plan for all stages of the development.

4.1.13 Erosion and Sedimentation

Impact:

Erosion and sedimentation from earthworks in the construction phase may result in loss of top soil or changed drainage conditions thereby affecting vegetation health.

Mitigation measures:

The NSW *Soil Conservation Act* 1938 requires rehabilitation works to stabilise and recreate a landscape that is compatible with the surrounding land and comparable to the pre-existing land use. Best practice management for erosion and sedimentation control are dealt with in other sections of the Environmental Assessment that deal with soil and water issues.

4.1.14 Pollutions, Litter & Illegal Dumping

Impact:

Polluting contaminants may poison fauna and flora. Uncontained litter such as plastic bags, synthetic fibres, etc. can be hazardous to wildlife. The Gara TSR at the entrance to the landfill site is vulnerable to illegal dumping which will be detrimental to the local environment and may significantly impact threatened flora and fauna in this EEC.

Mitigation measures:

Pollution and Litter Management Plan: The preparation and implementation of an appropriate pollution and litter management plan for the operation of the landfill. The plan will include:

- Placement of signage specifying no illegal dumping;
- Promote community awareness of biodiversity value of Gara TSR, identified as Key Habitat by NPWS, by placing signage similar to “Significant Roadside Habitat” at entrance to landfill site; and
- Management of the landfill boundary to maintain and remove any illegally dumped material within the TSR or Offset Area, whenever this has occurred.

5. Habitat Assessment

Threatened species known or likely to occur on the site include the barking owl, Eastern Bent-Wing Bat, Koala, regent honeyeater, square-tailed kite, squirrel glider and yellow bellied sheath-tailed bat, and declining woodland birds such as the brown treecreeper, black-chinned honeyeater, diamond firetail, Hooded Robin and Speckled Warbler. Habitat loss and degradation is the major threatening process for these species. Critical habitat components include resources for breeding, feeding and roosting. Areas of high significance are habitat patches of sufficient size and quality essential for breeding and sustaining populations in the long-term.

5.1 Habitat Quality

Overall the subject site and surrounding area generally provides moderate quality habitat for threatened flora and fauna species due to the presence of a range of habitat types.

The diversity of habitats on and around the study area is relatively high due to the presence of a mosaic of woodlands, grasslands, sedgelands, farm dams and the nearby Gara River. The Box Gum Woodland beside Waterfall Way has high habitat value and high biodiversity, many mature trees, and low numbers of exotic flora and fauna. The proposed operational area for the landfill is degraded and has low habitat quality due to previous clearing of native vegetation resulting in fragmentation and a scarcity of fully mature trees, previous removal of dead wood and dead trees in the cleared grassland, pushing of dead wood and dead trees into numerous large log piles in the Stringybark Woodland, heavy grazing by domestic livestock, high numbers of weed species, and the influence of key threatening processes including competition and grazing by the feral European Rabbit, predation by the European red Fox, and the likely presence of feral Cats.

The following assessment of habitat quality is based on parameters outlined in the 'Habitat Hectares' (Parkes *et al.* 2003) approach to assessing the condition of remnant vegetation.

5.1.1 Large Trees

Large trees can be a dominant feature of remnant native vegetation and their significant age makes them a difficult habitat feature to replace once lost. They provide roost and nest sites and food resources. The importance of hollows for wide ranging species can extend for a considerable distance from their location and impact significantly on the local environment (Parkes 2003).

Valuable hollows for wildlife are generally found in large living and dead trees. Hollow formation is dependent on the tree's history, its species and location. Generally, small hollows with narrow entrances suitable for small animals such as the brush-tailed phascogale take about 100 years to form. Hollows of a medium size and suitable for animals such as parrots can take around 200 years to form, and the larger and deeper hollows occupied by glossy black cockatoos, owls and brush-tailed possums can take a lot longer (NPWS 1999b).

Mature trees (greater than 40 cm diameter at breast height) are relatively common in the Box Gum Woodland beside Waterfall Way, but are uncommon to rare in the remainder of the site.

5.1.2 Dead Trees (Stags) and Dead Wood (Logs)

The removal of dead wood, either standing or fallen, can cause the broadscale change of woodlands into paddocks with isolated standing trees, little natural understorey and no woody debris on the ground. This leads to loss of important habitat such as hollows and decaying wood

(Gibbons & Lindenmayer 2002) for a wide variety of vertebrates, invertebrates and microbial species. The removal of dead trees and dead wood is a key threatening process.

Stags are defined as standing dead trees. Stags may provide perching and nesting habitat for a range of native fauna. Logs are defined as timber fallen and substantially detached from the parent tree. Logs have considerable influence upon the vegetation community by affecting soil moisture, structure and nutrition, and enhancing recruitment of some plant species. The presence/absence of logs can be indicative of disturbance processes, depending on the vegetation community and past land use. Logs provide habitat for many fauna species, ranging from invertebrates to reptiles and ground-dwelling mammals and provide foraging habitat for many woodland birds. Dead trees and fallen logs left *in situ* can enhance the habitat value of a woodland community.

In the partially cleared Stringybark Woodland in the southern section of the study area felled trees were pushed into numerous large piles over 10 yrs ago. These piles have become infested with Rabbits, Foxes (key threatening processes) and woody weeds contributing substantially to the ongoing degradation of habitat in the Stringybark Woodland. The large numbers of Rabbits as observed on and around the log piles during the nocturnal fauna surveys, would have a significant impact on ground cover in the vicinity. A large proportion of these piles will need to be relocated for construction of the landfill pit. The larger logs from these piles (>20 cm diameter) provide a valuable resource for habitat enhancement in revegetation and conservation areas on the landfill site.

Studies have shown a correlation between the presence of woody debris, bird species and the richness of other native fauna (e.g. Brown Treecreeper; Ford et al 2009). Fauna habitat on the site can be enhanced by retaining woody debris and leaf litter and reintroducing logs and branches in areas devoid of woody debris such as the cleared grassland and Box Gum Woodland.

5.1.3 Understorey

The greatest richness of plant species and vegetation at a site will almost always be found in the various shrub and forb/herb strata of a community (Parkes *et al.* 2003). Eighty-two (82) of the 158 species (52%) recorded during the flora survey were within the forb/herb strata. Eighteen (18) (22%) of these species were exotic.

The understorey of the Box Gum Woodland community demonstrates high levels of species diversity, the understorey of the Stringybark Woodland had moderate levels of species diversity, while the grassland, sedgeland and farm dams generally had low levels of species diversity.

5.1.4 Weeds

Weeds are plants that can compete successfully with native species and can potentially dominate a site to the exclusion of native plants. This could lead to a change in site conditions so that indigenous plant species formerly present are suppressed. Weeds may change the fuel or litter characteristics of a site, thereby altering the fire regime and also affecting the suitability of the habitat for frogs, reptiles, birds and mammals. Weeds may also prevent recruitment of previously dominant species including trees (Parkes *et al.* 2003).

Levels of weed invasion differ between vegetation communities on the study area, but overall were generally moderate to low. The Box Gum Woodland had low levels of weed infestation. Although 16 species of weeds were recorded in the Box Gum Woodland, none of them occurred at high densities. A total of 28 weed species were recorded in the grassland, sedgeland and Stringybark Woodland communities in the proposed development area for the landfill. The most visible weeds in these communities were Spear Thistle (*Cirsium vulgare*) which sometimes dominated areas of grassland, and occasional Hawthorn (*Crataegus monogyna*), Blackberry (*Rubus fruticosus*) and Sweet Briar (*Rosa rubiginosa*). The numerous large log piles in the Stringybark Woodland provide refuge for woody weeds and perching points for birds that deposit ingested weed seeds such as Hawthorn, Blackberry and Sweet Briar in their droppings.

Four species declared as noxious weeds under the *Noxious Weeds Act 1993* for the Armidale Dumaresq Local Government Area (LGA) are present on the study area. These are: African lovegrass (*Eragrostis curvula*), Bathurst burr (*Xanthium spinosum*), Blackberry and Sweet Briar. Appropriate weed management will be implemented to ensure the ongoing control and monitoring of these weeds in all parts of the landfill site.

5.1.5 Recruitment

The demonstrated potential for the recruitment of plant species within all major life forms and strata is an essential part of the long-term site viability (Parkes *et. al* 2003). The Box Gum Woodland and Stringybark Woodland both demonstrated active recruitment of trees as indicated by the presence of juveniles of the dominant species. There was no evidence of tree recruitment in the grassland and sedgeland communities.

5.1.6 Patch Size

The size of a patch (i.e. contiguous area) of remnant vegetation plays an important role in long-term viability with larger patches having a better prognosis for long-term survival. Many factors such as ‘edge effects’ (Parkes *et al* 2003) contribute to the demise of native vegetation fragments, including invasion by weed species. Large patches tend to support more species and populations than smaller ones, thus retaining greater genetic variability and providing refuge for species susceptible to disturbances.

The Box Gum Woodland is located in a portion of the Gara TSR. The existing Waterfall Way separates this community from a patch of approximately 76 ha of Box Gum Woodland to the north of the Waterfall Way and a smaller patch of 29.75 ha on the southern side of the Waterfall Way. Tree-stand density in the patch south of Waterfall Way varied from low in the western quarter, to high in the eastern half. The remains of the old highway run through the southern portion of this community. The old road base has been ripped, but the soil is still compact and dominated by clays and has been colonised by herbs and shrubs but not trees. However, the width of this road is generally less than 12 m and does not present a dividing barrier within this community.

The regrowth Stringybark Woodland occurred in multiple irregular shaped patches. These patches were predominantly less than 10 ha, with one single larger patch of 32 ha.

Although the vegetation on the study area is fragmented to some extent by clearing for pastoral use and roadways, patches of similar vegetation occur nearby. Vegetation on the site, therefore, is likely to support more species than isolated remnants of similar size and condition.

5.1.7 Connectivity / Landscape Value

Ecological connectivity is the degree to which the landscape facilitates or impedes movements among patches (Bennett 1999). Long-term viability of populations of many species in variegated or fragmented landscapes is dependent on the extent to which individuals are able to move between fragmented populations.

Ecological connectivity is enhanced by linking woodland fragments together and by linking woodlands with other natural ecological communities such as native grasslands, wetland areas and forests. Woodland of lower vegetation condition or habitat quality can provide a buffer to woodland of higher conservation value. Similarly, other ecosystems such as grasslands or forest can provide a buffer to woodlands (and vice versa).

Buffers are areas that separate habitat from more intensive land-uses, and hence provide natural areas with some protection (buffer) from 'edge-effects' such as human disturbance and weed invasion.

Landscape Value is an assessment of the spatial configuration of vegetation (i.e. total tree cover, connectivity and adjacency of native vegetation up to 1000 ha around the site) (Gibbons *et al* 2005). The vegetation cover of the three predominant vegetation types in the landscape was measured at 3 different radii (1.75 km, 550 m and 200 m).

Table 4. Current landscape cover values within varying radii from the site of the proposed new landfill pit

Vegetation type	Percent cover within 200m radius of landfill	Percent cover within 550 m radius of landfill	Percent cover within 1.75 km radius of landfill
Box Gum Woodland	0	0	5%
Cleared Grassland	22%	39%	51%
Stringybark Woodland	77%	60%	43%

The area covered by the 550 m radius encompasses most of the impact area for the proposed operational landfill area and proposed areas for offsets (Figure 8). The area covered by the 1.75 km radius encompasses the study area, including the southern section of the TSR, the proposed access route, proposed landfill operational areas, proposed offset areas and parts of adjoining rural properties (Figure 8).

The landscape vegetation cover at both the 550 m and 1.75 km radii is categorised as a 'variegated landscape', i.e. between 30-70% vegetation cover. The study area forms part of a landscape scale mosaic of cleared grasslands, remnant and regrowth vegetation. The vegetation on the study area could be expected to provide connecting habitat for species that are capable of moving through a cleared woodland mosaic landscape. Species that require continuous forested areas are not likely to occur on or move through the study area.

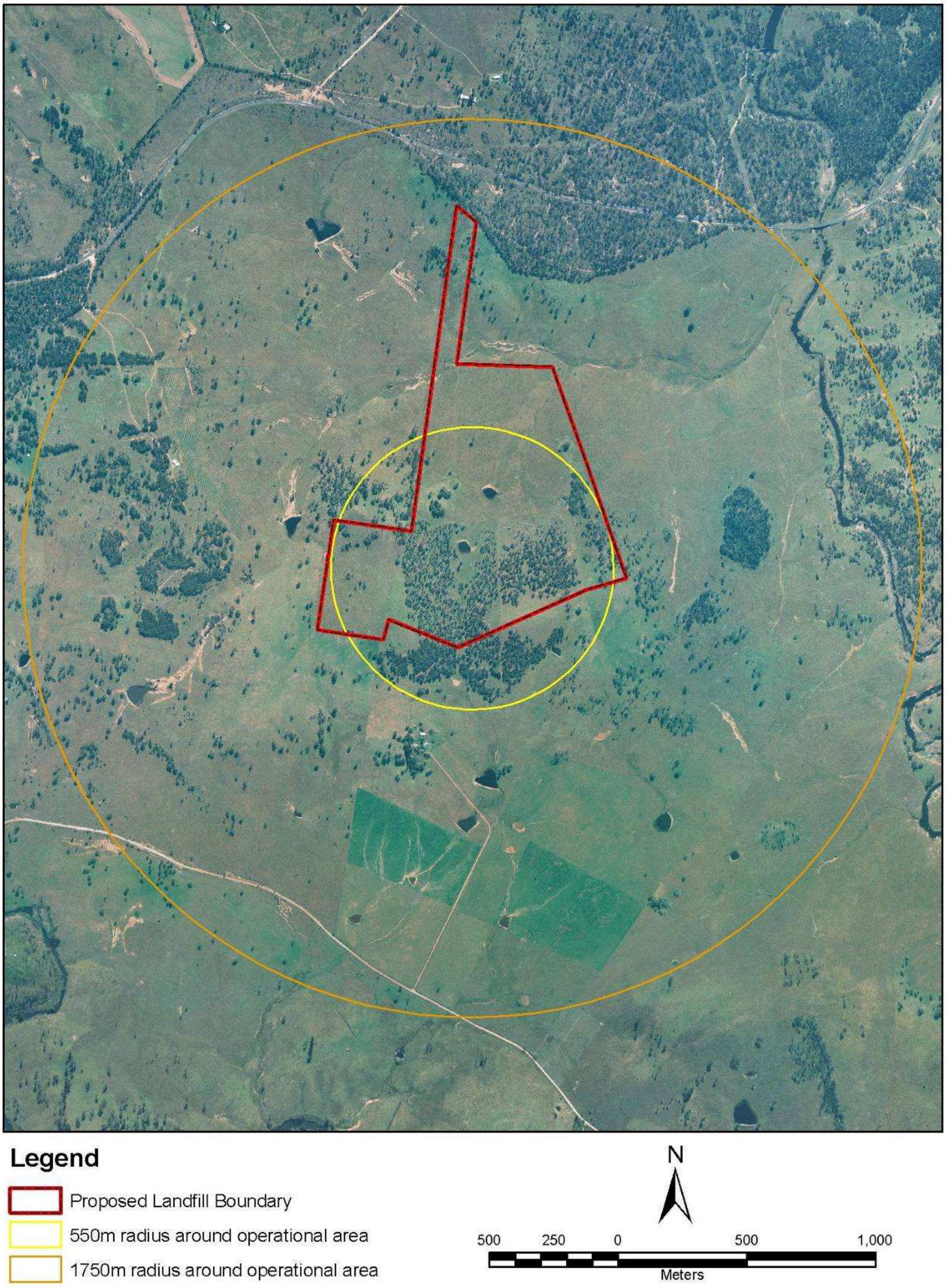

Figure 8. 550m and 1750m radii from the approximate centre of the proposed operational area

6. Threatened Species Evaluation

The evaluation of threatened species known or likely to occur in the study area is closely linked with the assessment of habitat on the site. Desktop searches of available databases revealed threatened species (TSC and EPBC listed species) recorded or likely to occur within 20 km of the landfill site. The site investigation provided further information on flora and fauna and habitat attributes of the site to refine the evaluation of threatened species.

6.1 Threatened Flora

Flora species listed under the TSC Act or EPBC Act, listed on the ROTAP list (Rare or Threatened Australian Plants (Briggs and Leigh 1996) or regionally significant species that occur in the New England Tableland region are listed in Table 5. These species are those known to have distributions that include the study area or habitat requirements similar to that present within the study area or surrounding area.

One threatened plant species, Narrow-Leaved Black Peppermint (*Eucalyptus nicholii*), and one ROTAP species, Bendemeer White Gum (*E. elliptica*), were recorded on the study area. Narrow-Leaved Black Peppermint is listed as vulnerable under Schedule 2 of the *NSW TSC Act 1995* and as vulnerable under the *EPBC Act 1999*. A small population of six adults and five juveniles were found in the Box Gum Woodland beside Waterfall Way highway. They all occurred within 40 m of the corner post of the far north-western tip of the proposed development area (Figure 6).

The Narrow-Leaved Black Peppermint is endemic to the Northern Tablelands of NSW where it occurs from Niangala in the south to Glen Innes in the north (Williams 1992; Brooker & Kleinig 1999; Hill 2002). A large population is reserved close to its western limit in Single National Park (c. 30 km north-west of Guyra) while another significant population is known to occur approximately 10 km east of the study area along the Waterfall Way (Figure 9). Bendemeer White Gum is a rare species (ROTAP) on the Northern Tablelands. This species is scattered over the southern part of the Northern Tablelands (e.g. Walcha, Bendemeer and Wollomombi districts). It prefers grassy woodland on sandy soils. It is known to occur further east of the study area along the Waterfall Way.

6.1.1 Potentially Occurring Threatened Flora

The NPWS Wildlife Atlas records of flora for a 20 km radius of the study area were obtained to ascertain if any threatened species had been recorded at the study area or in a similar habitat in the district (Appendix G). The records revealed that the following 11 species have been recorded within 20 km of the study area: *Picris evae* (Hawkweed), *Lepidium hyssopifolium* (aromatic peppercress), *Bertya ingramii* (narrow-leaved bertya), *Haloragis exalata subsp. velutina* (tall velvet sea-berry), *Eucalyptus magnificata* (northern blue box), *Eucalyptus nicholii* (Narrow-Leaved Black Peppermint), *Eucalyptus rubida subsp barbigerorum* (blackbutt candlebark), *Dichanthium setosum* (bluegrass), *Grevillea beadleana* (Beadle's grevillea), *Hakea fraseri* (gorge hakea) and *Thesium australe* (austral toadflax).

The EPBC Act Protected Matters Search Tool identified 13 flora species listed as threatened under the EPBC Act that may occur within a 20 km radius of the study area (Appendix H). These species are *Bertya ingramii* (narrow-leaved bertya), *Bothriochloa biloba* (lobed blue-grass), *Callistemon pungens*, *Cryptostylis hunteriana* (leafless tongue-orchid), *Dichanthium setosum*, *Diuris pedunculata* (small snake orchid), *Eucalyptus nicholii* (Narrow-Leaved Black Peppermint), *Grevillea beadleana* (Beadle's grevillea), *Hakea fraseri* (gorge hakea), *Haloragis exalata* subsp. *velutina*, *Picris evae* (hawkweed), *Pultenaea campbellii* (New England bush-pea), and *Thesium australe* (austral toadflax).

Of the 16 threatened species recorded within 20 km of the study site by the NPWS wildlife Atlas and/or the EPBC Protected Matters Search Tool, 10 are considered to have suitable habitat represented on the study area (shaded grey in Table 5). These species, and aspects of the habitat on site suitable for them, are as follows:

- *Amphibromus pithogastrus*: Moist, grassy seepage
- *Asperula charophyton*: Moist, grassy seepage
- *Bothriochloa biloba:* Disturbed grassland
- *Dichanthium setosum*: Grassy woodland
- *Discaria pubescens*: Woodland and forest, often in rocky situations
- *Diuris pedunculata*: Moist areas, open sclerophyll forest to grassland
- *Eucalyptus nicholii*: Grassy open forest and woodland on poor soils
- *Ozothamnus adnatus*: Grassy open forest and woodland on poor soils
- *Senecio macranthus*: moist gullies in sclerophyll forest
- *Thesium australe*: Grassy woodland

An assessment of significance (7-part test) of TSC listed species and potential impacts of the proposed development on these species is presented in Appendix A. An assessment of potential impacts on matters of national significance (EPBC Act) is presented in Appendix B.

Table 5. Evaluation of rare or threatened flora to identify species with potential habitat on the study area.

Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct
(References: Harden 1990; 1991; 1992; 1993, Ayers *et al.* 1996, Briggs and Leigh 1996, Creamer 1999, NPWS 2003. (ROTAP code –Appendix L).

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Acacia acrionastes	E	-	3RC	Not recorded	Grows in dry woodland or forest on volcanic soils around Ashford and Pindari dam. It commonly occurs in dry sclerophyll forest on granite outcrops. Probably only able to cross areas of unsuitable habitat up to 100m wide as seeds are dispersed by ants, small mammals and small birds.	Habitat not suitable Not likely to occur
Acacia atrox	E	-	2E-V	Not recorded	Known from a single population west of Inverell. Grows in deep clay soils on basalt in the upper slope and crest of a low hill. Flowering period May-July. Possibly only spreading by suckering. No pods have been observed.	Habitat not suitable Not likely to occur
Acacia ingramii	-	-	2RCa	Not recorded	This species is not listed as threatened but is classed as Rare by Briggs and Leigh (1996). Abundant in the gorge country along the Gara River to the south of the study area. Highly unlikely to occur in the study area due to a lack of suitable habitat.	Habitat not suitable Not likely to occur
Acacia jucunda	E	-		Not recorded	Generally grows in dry forest or woodland in the Yetman district. Grows in Callitris and Eucalypt woodland on heavy and loamy soils. Flowering late winter to early spring.	Habitat not suitable Not likely to occur
Acacia macnuttiana	E	V	2VCi	Not recorded	Usually on granite and often near streams, in dry sclerophyll forest and heath at altitudes of 500-1000m. Associated species include *Allocasuarina littoralis*, *Angophora floribunda*, *Bursaria spinosa*, *Callistemon flavovirens*, *Eucalyptus biturbinata*, *Leptospermum brachyandra*. Flowering period is July to September. This species would be expected to regenerate from seed after fire. Prolonged absence of fire disturbance may preclude regeneration; too frequent fires may eliminate it.	Habitat not suitable Not likely to occur
Acacia pubifolia	E	V	2VC	Not recorded	Grows on rocky outcrops and in woodlands on sandy soils derived from granite.	Habitat not suitable Not likely to occur
Amphibromus pithogastrus	-	-	3K	Not recorded	This species is not listed as threatened but is known to be very rare on the Northern Tablelands. Previously recorded near Cooney Creek to the east of the study area. Favours moist, grassy seepage areas which are present in the study area but no plants were found despite specifically targeting this species.	Potential habitat present. Assessment of Significance applied
Asperula charophyton	-	-	3RCa	Not recorded	Scattered over the Northern Tablelands (e.g. Mother of Ducks Lagoon Nature Reserve near Guyra and Cathedral Rock National Park). Favours moist, grassy seepage areas which are present in the study area but no plants were found despite specifically targeting this species	Potential habitat present. Assessment of Significance applied

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Asterolasia sp. 'Dungowan Creek'	E	-	-	Not Recorded	Known from a single population near Tamworth. Grows in rocky alluvial soil along a creek bank, in riparian community with *Casuarina cunninghamiana* the dominant species.	Habitat not suitable Not likely to occur
Astrotricha roddii	E	E	3VCa	Not recorded	Low dry woodland and shrublands on granite and acid volcanic outcrops, often in rock crevices. Appears to be restricted to the margins and crevices of rocky outcrops primarily in shrubland. This habitat is of limited extent but occurs along the banks of the Severn River and in the adjacent hills. Occurs on exposed granitic and acid volcanic outcrops, or ignimbrites and lava rocks or porphyry.	Habitat not suitable Not likely to occur
Bertya Species A Cobar-Coolabah	V	V	2V	Not recorded	Occurs in a range of habitats ranging from stony mallee ridges and cypress-pine forest on red soils in the west, to cliff edges in open eucalypt forest in the east.	Habitat not suitable Not likely to occur
Bertya ingramii	E	E	2VCit	Not recorded	Previously recorded in the gorge country along the Gara River to the south and at Dangars and Mihi Falls. Highly unlikely to occur in the study area due to a lack of suitable habitat.	Habitat not suitable Not likely to occur
Boronia granitica	V	E	3VC-	Not recorded	Occurs in fissures and crevices of granite and acid volcanic outcrops and in forests on granite scree and shallow soils. Confined to healthy vegetation associated with the large expanses of granite outcropping found at mid altitudes (700-1200 m asl) on the dry western side of the New England Batholith. At Severn River Nature Reserve a few plants occur on shallow soil over acid volcanics, but most are on deep red soil.	Habitat not suitable Not likely to occur
Boronia ruppii	E	-	-	Not recorded	Restricted to Woods Reef, east of Barraba. Grows in dry eucalypt woodland on serpentine soils.	Habitat not suitable Not likely to occur
Bothriochloa biloba	-	V	-	Not recorded	Grows in Eucalypt woodland on basaltic hills, in grassland on drainage slopes and floodplains on a variety of soils, brown and black clays, red earth soils. Associated tree species include *E. albens*, *E. camaldulensis*, *E populnea* ssp. *bimbil*, *Angophora floribunda*. Often occurs in areas with ground disturbance	Potential habitat present Assessment of Significance applied
Cadellia pentastylis	V	V	-	Not recorded	Grows mainly in vine thickets or dry rainforest, and, more rarely in rainforest. A relic rainforest species favouring upper and mid slopes, ridges and gullies on undulating terrain on various geologies including sandstone, conglomerate and claystone. Soil nutrient levels are low to fair and soil types range from sandy clay to clay. Aspect ranges from 50-330 degrees with most known populations having northerly aspect. Mostly at elevations of 300-450m. Commonly found in White Box Woodland (*Eucalyptus albens*) with White Cypress Pine (*Callitris glaucophylla*). Also occurs as a tall emergent tree in semi evergreen vine thickets and in localised clumps among Brigalow Belah communities.	Habitat not suitable Not likely to occur

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Callistemon pungens	-	V	3RC-	Not recorded	Dry sclerophyll forests, woodlands, riparian areas, and rocky areas including crevices and scree. Grows in or near rocky watercourses, usually in sandy creek beds on granite or sometimes on basalt.	Habitat not suitable Not likely to occur
Cryptostylis hunteriana	V	V	3VC-	Not recorded	This species is saprophytic. Occurs mostly in coastal heathlands, dry sclerophyll forests, dunes (including stabilised sands), riparian (stream-side) areas, swampy forests, swampy areas and wetlands	Habitat not suitable Not likely to occur
Dichanthium setosum	V	V	-	Not recorded	Grows in Eucalypt woodland and grassland. Has been recorded on basalt, black clay and red-brown hardsetting soils. Associated species include *Bothriochloa decipiens* and *Macrozamia stenomera*.	Potential habitat present. Assessment of Significance applied
Digitaria porrecta	E	E	3E	Not recorded	Native grassland, woodlands or open forest with a grassy understorey, on richer dark and fine textured clays (usually highly fertile). This species seems to require a level of disturbance. Mostly found along roadsides and TSRs where there is light grazing and sporadic fire. Associated species include *Geijera parviflora*, *Casuarina cristata*, *Dichanthium sericeum*, *Panicum decompositum*, *Digitaria divaricatissima*, *Aristida leptopoda*.	Habitat not suitable Not likely to occur
Discaria pubescens	-	-	3RCa	Not recorded	In woodland and forest, often in rocky situations; widespread, but considered endangered. Scattered over the Northern Tablelands (e.g. Armidale and Dangars Falls). No plants were found in the study area despite specifically targeting this species	Potential habitat present. Assessment of Significance applied
Diuris pedunculata	E	E	2E	Not recorded	Occurs in a range of vegetation communities from open sclerophyll forest to grassland. Often associated with moist and/or swampy areas within these communities. Has been recorded from shale and trap soil, and on fine granite and among boulders.	Potential habitat present. Assessment of Significance applied
Diuris tricolor	V	V	3K	Not recorded	Grows in grassland and cypress-pine woodland, in sandy soils in flat country or on top of small hills	Habitat not suitable Not likely to occur
Eucalyptus caleyi subsp. *ovendenii*	V	V	-	Not recorded	Known from a limited area west of Tenterfield. All known stands are on privately held property on drier shallower soils of moderate fertility in open grassy woodlands with *Eucalyptus melliodora* and *E. dealbata* on rough granite. This species occurs within the range of ssp. *caleyi*, but occupies the crests of broad high ridges in a replacement pattern. Subsp. *caleyi* occurs on lower slopes in the same general area and integration occurs in intervening areas.	Habitat not suitable Outside of known distribution Not likely to occur

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Eucalyptus elliptica	-	-	3KC-	Recorded on site	Scattered over the southern part of the Northern Tablelands (e.g. Walcha, Bendemeer and Wollomombi districts). Prefers grassy woodland on sandy soils. Also known to occur further east of the study area along the Waterfall Way.	Recorded on site. No Assessment of Significance applied for ROTAPs
Eucalyptus magnificata	E	-	3K	Not recorded	Scattered along the gorge rim and adjacent plateau in the eastern half of the Northern Tablelands (e.g. Metz Gorge and Hillgrove district). Highly unlikely to occur in the study area due to a lack of suitable habitat	Habitat not suitable Not likely to occur
Eucalyptus mckieana	V	V	2V	Not recorded	Confined to the drier western side of the New England Tablelands from near Inverell south to Bendemeer. Although locally abundant in dry sclerophyll forest or woodland in a few areas, such as near Gilgai, the general distribution is very patchy. Gently undulating to flat areas at altitudes of approx. 600-1050m. Mean annual rainfall is 650-750mm. Grows on gently undulating to flat areas on a range of soil types including deep clay loams on metasediments, but more commonly on sandy loams derived from granite and quartz porphyrites. Associated species include *Angophora floribunda*, *E. blakelyi*, *E. bridgesiana*, *E. prava* and *Callitris endlicheri*.	Habitat not suitable Not likely to occur
Eucalyptus michaeliana	-	-	3RCa	Not recorded	Scattered along the gorge rim and adjacent plateau in the eastern half of the Northern Tablelands (e.g. Hillgrove district). Highly unlikely to occur in the study area due to a lack of suitable habitat	Habitat not suitable Not likely to occur
Eucalyptus nicholii	V	V	3V	Recorded on site	Grassy open forest or woodland on shallow and infertile soils, mainly on granite. This species is endemic to the Northern Tablelands of NSW where it occurs from Niangala in the south to Glen Innes in the north (Williams 1992; Brooker & Kleinig 1999; Hill 2002). A large population is reserved close to its western limit in Single National Park (c. 30 km north-west of Guyra) while another significant population is known to occur c. 10 km east of the study area along the Waterfall Way.	Recorded on site. Assessment of Significance applied
Eucalyptus rubida subsp *barbigerorum*	V	V	-	Not recorded	Known only from scattered locations on the northern tablelands from near the Moonbi Ranges and northwards to the west of Guyra and Glen Innes. Grows on cold flats in open forest, grassy or shrubby woodland on soils of medium to high fertility. Occurs on deep nutrient-rich clay loams as a dominant or locally abundant component of grassy woodlands. Associated species include *Acacia fimbriata*, *Acacia melanoxylon*, *Angophora floribunda*, *Eucalyptus dalrympleana* ssp *heptantha*, *E. melliodora* and *E. viminalis*.	Habitat not suitable Not likely to occur

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Euphrasia collina subsp. *muelleri*	E	E	-	Not recorded	Mueller's Eyebright is a semi-parasitic plant. The host range of the species is unknown but may be broad. Stems die back annually to a perennial rootstock. Successful dispersal is normally only likely to occur along continuous 'corridors' of resident habitat. Very little is known of the habitat of the species in NSW. Early records from other states indicate that it grows in 'open meadows' and possibly damp places in grassland, heath and heathy woodland. Recorded at upper Macintyre River (Inverell area) in the early 1900's.	Habitat not suitable Not likely to occur
Euphrasia ruptura	E4	Extinct	1X	Not recorded	Unknown	
Grevillea beadleana	E	E	3ECi	Not recorded	Usually found on steep granite slopes at high altitudes, although a population at Shannon Creek is at a lower elevation on sandstone Usually within open eucalypt forest with a shrubby understorey. Known from four separate areas, the Torrington area west of Tenterfield, Oxley Wild Rivers National Park, Guy Fawkes River National Park and at Shannon Creek south-west of Grafton. Historical records suggest it was also once found near Walcha.	Habitat not suitable Not likely to occur
Hakea fraseri	V	V	2VC-	Not recorded	Mainly occurs on the dry and steep rocky slopes of river gorges. Sometimes grows in open woodland on gorge rims. Found only in the upper Macleay River gorges, and the escarpment country in Oxley Wild Rivers National Park.	Habitat not suitable Not likely to occur
Hakea pulvinifera	E	E	2ECi	Not recorded	Known from a single population growing on a hard rocky hillside near Lake Keepit	Habitat not suitable Not likely to occur
Haloragis exalata subsp. *velutina*	V	V	-	Not recorded	Scattered along the eastern edge of the Northern Tablelands where it is usually associated with steep, rocky country near watercourses. Highly unlikely to occur in the study area due to a lack of suitable habitat.	Habitat not suitable Not likely to occur
Homoranthus bornhardtiensis	E	V	-	Not recorded	Occurs in open and exposed sites in shrubland and low woodland on granite outcrops between 650 and 970m altitude. Often grows in rock crevices on bare rocky slopes and in surrounding shallow soils.	Habitat not suitable Not likely to occur
Homoranthus prolixus	V	V	2V	Not recorded	Grows in heath on shallow soils among crevices in granite outcrops.	Habitat not suitable Not likely to occur
Lepidium hyssopifolium	E	E	3ECi+	Not recorded	Grows in many vegetation types including Open Eucalypt Woodland and Low Open Casuarina Woodland with grassy understorey and Grasslands with an annual rainfall of 600-700mm. This species can tolerate high soil disturbance and is commonly found in areas where the groundcover is dominated by introduced species. Associated species include *Bromus diandrus*, *Dactylis glomerata*, and *Pinus radiata*.	Habitat not suitable Not likely to occur

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Macrozamia humilis	E	-	-	Not recorded	Known from a single population in low dry woodland on sandy soil on an outcrop of laterite capped granite.	Habitat not suitable Not likely to occur
Monotaxis macrophylla	E	-	-	Not recorded	Occurs in isolated patches on rocky ridges and hillsides on granite and acid volcanics, and also in coastal heaths and along roadsides. This species is a moderately resilient fire ephemeral (comes up after fire, dormant between fires), an obligate seeder and has a long-lived seed bank.	Habitat not suitable Not likely to occur
Muehlenbeckia costata	V	-	Vulnerable	Not recorded	Grows in coarse sandy soils in heath, mallee and open eucalypt woodland in granitic or acid volcanic outcrops at higher altitudes. In NSW, it is only known from granitic outcrops on the New England Batholith in the Northern Tablelands.	Habitat not suitable Not likely to occur
Ozothamnus adnatus	-	-	3KC-	Not recorded	Grows in sclerophyll forest and woodland, usually on sandy soil; rare, south from Guyra district. Scattered over the Northern Tablelands and recently found 2 km to the west of the study area along the Waterfall Way. No plants were found despite specifically targeting this species	Potential habitat present. Assessment of Significance applied
Phebalium glandulosum ssp. *eglandulosum*	E	V	-	Not recorded	This species is known from the Torrington district and Warialda. Grows amongst granite outcrops in heath.	Habitat not suitable Not likely to occur
Philotheca ericifolia	V	V	3RC-	Not recorded	Spreading shrub 1-2 m high. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies, in the upper Hunter Valley and Pilliga to Peak Hill district.	Habitat not suitable Not likely to occur
Picris evae	V	V	3V	Not recorded	Grows on the New England Tablelands, north from the Armidale area. This species is found in open eucalypt forest, grassy woodland and native grassland. This species has fine wind-dispersed seeds. Propagules are likely to move large distances between areas of suitable habitat. Occurs on black soils.	Habitat not suitable Outside of known distribution Not likely to occur
Polygala linariifolia	E	-	-	Not recorded	Sandy soils in dry eucalypt forest and woodland with a sparse understorey. An inconspicuous herb with longevity estimated at about 20 years. Not known from the tablelands.	Outside of known distributions Not likely to occur
Pomaderris queenslandica	E	-	-	Not recorded	Grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Habitat not suitable Not likely to occur
Pultenaea campbellii		V	-	Not recorded	Grows in dry sclerophyll forest on light gravelly soil.	Habitat not suitable Not likely to occur
Pultenaea stuartiana	V	V	-	Not recorded	On granite in open forest. Locally abundant in restricted areas around Severn River and Kings Plains area.	Habitat not suitable Not likely to occur

Species	TSC Act	EPBC Act	ROTAP Code	Results of Flora Survey	Habitat Required/Distribution	Presence of Suitable Habitat
Rutidosis heterogama	V	V	2VCa	Not recorded	A perennial herb that grows in heath and, occasionally, open forest. Propagules are likely to move large distances between areas of suitable habitat by wind dispersal. Often found along disturbed roadsides.	Habitat not suitable Not likely to occur
Senecio macranthus	-	-	3RC-	Not recorded	Grows in moist gullies in sclerophyll forest; mainly in the ranges from Wollomombi Falls south to Tallong and inland to the Warrumbungle Mtns. Rare on the Northern Tablelands where known from just a few scattered populations (e.g. Wollomombi Falls). No plants were found despite specifically targeting this species	Potential habitat present. Assessment of Significance applied.
Swainsona sericea	V	V	-	Not recorded	Grows in grassland and eucalypt woodland sometimes with Callitris species.	Habitat not suitable Not likely to occur
Thesium australe	V	V	3VCi+	Not recorded	Grows in grassland and Eucalypt woodland, often in damp sites. This species occurs on a wide range of soils, rainfall regimes and geology. *Thesium australe* is a semi-parasitic herb, and the hosts are most probably *Themeda australis* and *Poa* spp. Other associated species include *Eucalyptus blakelyi*, *E. albens* and *E. viminalis*. Common to abundant throughout much of the Northern Tablelands. Favours areas of dense Kangaroo grass and appears to be highly sensitive to grazing.	Marginal habitat present. Assessment of Significance applied
Tylophora linearis	E	E	3E	Not recorded	Grows in vine thickets and shrubby woodland in the Barraba, Mendooran, Temora and West Wyalong districts.	Habitat not suitable Not likely to occur

6.2 Threatened Fauna

Four (4) threatened fauna species (Speckled Warbler, Diamond Firetail, Koala and Eastern Bent-Wing Bat) were recorded in the study area (Figure 7). A fifth, the Little Lorikeet, has been recorded in the Gara River TSR north of Waterfall Way (Appendix F), and potentially occurs at least in the TSR traversed by the landfill access road, where it is likely to forage and breed in Box Gum Woodland in good eucalypt flowering years (Courtney & Debus 2006).

Speckled Warbler: In the autumn survey one family group of 2-3 birds was observed in the Stringybark Woodland community and another small group in the Box Gum Woodland community. In the spring survey two family groups of 2-3 birds were observed in the gully and saddle above the dam in the stringy bark woodland, and one pair in the Box Gum Woodland. In spring 2009 a group was detected in the same general area in the Stringybark Woodland (landfill site), and another in the Box Gum Woodland (TSR).

Diamond Firetail: In the autumn survey one bird was observed at the dam in the Stringybark Woodland. In the spring survey one bird was observed at the same dam and another one in the Box Gum Woodland about 100 m west of the dam in the TSR. The species was not recorded in spring 2009.

One **Koala** was observed by spotlight during the spring fauna survey in the Box Gum Woodland beside Waterfall Way. The individual was located in a mixed clump of foliage belonging to a Yellow Box and a Blakely’s Red Gum beside the northern boundary fence of *Edington* and approximately 200 m south-east of the dam in the TSR (Figure 7). A detailed search for Koala in November 2009 revealed evidence of Koalas (scats and scratches) near several trees in the Stringybark Woodland at the landfill site (Section 6.4.2). However, no Koalas were observed at either the landfill site or in the TSR.

Eastern Bent-Wing Bat echolocation calls were detected in the Stringybark Woodland.

6.3 Threatened Fauna with a Final Determination Pending

Three (3) bird species, although not yet listed as threatened, are currently the subject of a Preliminary Determination to list them as such (TSC Act – Vulnerable). They were detected in both the Box Gum Woodland in the TSR, and in the Stringybark Woodland in the proposed development area (Figure 7; Appendix D). These species are the Little Eagle, Scarlet Robin and Varied Sittella.

One Scarlet Robin territory was identified in the Stringybark middle gully area of the landfill footprint in spring 2009, in the general vicinity of previous records in 2005 (Appendix D). Another was observed in the eastern half of the TSR in 2005.

A group of Varied Sittellas was identified in the Stringybark middle gully area of the landfill footprint in spring 2009, in the general vicinity of previous records in 2005 (Appendix D). Another group was detected in the eastern half of the TSR in 2005-06.

A breeding pair of Little Eagles was present during the spring 2005 survey, and had an active nest in the first tall Stringybark tree in the gully above the dam within the Stringybark Woodland. This species is protected in NSW, and therefore any clearing that may affect the nest tree should be undertaken outside of the breeding season (which is August to January, Debus 1984). Little Eagles usually breed from the same nest over a number of years. However, they are known to readily build a new nest, or use an alternative nest, when a previous nest is damaged or destroyed, or the eagles are disturbed (Debus *et al.* 2007; Debus & Ley 2009).

In spring 2009 the pair of Little Eagles had a new nest site, in a tall Yellow Box on the western edge of the landfill footprint (located at GPS point 56J 383203 m E, 6618998 m; Figure 7). On 23 November there was a half-grown chick in the nest, about 1 month old, indicating a likely nest-leaving date of late December. However, the young eagle would be dependent on the nest as a feeding platform for a further week or two after leaving the nest, and on the woodland around the nest site for a further two months after leaving the nest (Debus & Ley 2009).

It is recommended that the current (2009) Little Eagle nest tree and surrounding trees, to a radius of 50 m from the nest, be incorporated into the offset zone around the landfill footprint, that construction works take place outside the breeding season (i.e. in February-July), and that construction approaches the nest site gradually from a more distant starting point. If it is not practicable to retain the nest tree and buffer, it is recommended that removal of the tree takes place outside the eagles' breeding season (i.e. between February and July), and that a healthy tree of similar age and size is included in the offset zone. The last provision, of an alternative nest tree in the offset zone, should apply regardless, in case the pair abandons the current nest site when construction approaches it.

6.3.1 Potentially Occurring Threatened Fauna

The NPWS Wildlife Atlas records of fauna for a 20 km radius of the study area were obtained to ascertain if any threatened species had been recorded at the study area or in a similar habitat in the district. The records revealed that 29 listed threatened species have been recorded within 20 km of the study area (Figure 10, Appendix G).

The EPBC Act Protected Matters Search Tool identified 14 fauna species listed as threatened under the EPBC Act that may occur within a 20 km radius of the study area (Appendix H).

Table 6 presents an evaluation and summary of habitat requirements of 56 threatened fauna species known to occur in the New England Tableland Bioregion, with species considered to have potential habitat present on the study site highlighted with grey shading. These species are those known to have distributions that include the study area or habitat requirements similar to that present within the study area or surrounding area.

Table 6. Evaluation of threatened fauna to identify species and populations with potential habitat on the study area.

Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct
(References: Baldwin 1975, Cayley 1995, Churchill 1998, Debus 1998, Garnett 1993, Marchant & Higgins 1993, Menkhorst & Knight 2001, NPWS 1997a, NPWS 1997b, NPWS 1998a, NPWS 1999a, NPWS 1999c, NPWS 2000a, NPWS 2000b, NPWS 2001a, NPWS 2001b, Parnaby 1992, Robinson 1993, Simpson & Day 1993, Slater 1986, Strahan 1995, Swan 1990, Triggs 1992).

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Australasian Bittern *Botaurus poiciloptilus*	V		Not recorded	Permanent freshwater wetlands with tall dense vegetation, which provides shelter during the day. Feeds mainly at night on frogs, yabbies, spiders, insects and snails in still shallow water near thick vegetation.	Habitat not suitable Not likely to occur
Barking Owl *Ninox connivens*	V		Not recorded	Woodland, open forest and riparian woodland. Nests in large hollows. Typically roosts in tall, dense understorey trees particularly wattles and she-oaks. Territories range from 30 to 1000 ha.	Potential foraging habitat Assessment of Significance applied
Bell's Turtle *Elseya bellii*	V	V	Not recorded	Shallow to deep pools in upper reaches of the Namoi, Gwydir and MacDonald Rivers in granite areas. Nests sandbanks in spring and summer.	Habitat not suitable Not likely to occur
Black-chinned Honeyeater *Melithreptus gularis gularis*	V		Not recorded	Dry woodlands and wattle shrublands. Prefers Box-ironbark Woodlands and River Red Gum woodlands, and stands of flowering shrubs. Feed on nectar, honeydew and insects.	Potential habitat present Assessment of Significance applied
Black-necked Stork *Ephippiorhynchus asiaticus*	E		Not recorded	Swamps, lagoons, floodplains, farm dams and irrigated. Occasionally feeds in open grassy woodland. Builds large stick nests in large tree near water.	Habitat not suitable Not likely to occur
Black-striped Wallaby *Macropus dorsalis*	E		Not recorded	Confined to stands of Brigalow with a dense shrub layer and open areas nearby for feeding.	Habitat not suitable Not likely to occur
Black-throated Finch (southern ssp.) *Poephila cincta*	E	V	Not recorded	Eucalypt woodland and riparian woodland, including paperbark and wattle shrubland. Favours areas close to water with a dense understorey of seeding grasses and shrubs.	Habitat not suitable Not likely to occur
Blue-billed Duck *Oxyura australis*	V		Not recorded	Large, deep, permanent wetlands, both natural and artificial. Flocks form during non-breeding season (winter) on large bodies of open water. Densely vegetated swamps and marches occupied during breeding season (Spring).	Habitat not suitable Not likely to occur
Booroolong Frog *Litoria booroolongensis*	E	E	Not recorded	On or under boulders and debris within and adjacent to rocky mountain streams and on grassy banks of slow moving streams. Breed in summer. Very few recent records in north of range.	Habitat not suitable Not likely to occur
Border Thick-tailed Gecko *Underwoodisaurus sphyrurus*	V	V	Not recorded	Rocky hills with dry open eucalypt forest or woodland. Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Most common in granite hills of the New England Tablelands.	Habitat not suitable Not likely to occur
Brown Treecreeper *Climacteris picumnus victoriae*	V		Not recorded	Drier eucalypt woodlands. Favour open areas with short grass or bare ground with dead timber but few shrubs. Nest in hollows and fallen logs.	Potential habitat present Assessment of Significance applied

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Brush-tailed Phascogale *Phascogale tapoatafa*	V		Not recorded	Dry forests and woodlands with hollow bearing trees. Forage for invertebrates and small vertebrates on trunks and branches of rough barked trees. Also required nectar from flowering eucalypts. Shelter during the day in hollow tree limbs, stumps and certain bird nests.	Habitat not suitable Not likely to occur
Brush-tailed Rock Wallaby *Petrogale penicillata*	E	V	Not recorded	Typically occupy north facing cliffs in dry eucalypt forest and woodland. Shelters in rock crevices, caves or overhangs during the day and feeds in grassy areas above or below cliffs in the evening. Feeds on grasses, sedges, shrub leaves, ferns and roots.	Habitat not suitable Not likely to occur
Bush Stone-curlew *Burhinus grallarius*	E		Not recorded	Lightly timbered open forest and woodland, or partly cleared farmland with woodland remnants. Prefers areas with dry leaf litter, fallen timber and sparse ground cover.	Habitat not suitable Not likely to occur
Cotton Pygmy-goose *Nettapus coromandelianus*	E		Not recorded	Deep, permanent freshwater lakes, lagoons, swamps and dams, particularly those vegetated with water lilies and other aquatic vegetation	Habitat not suitable Not likely to occur
Diamond Firetail ***Stagonopleura guttata***	V		Recorded on site	Grassy eucalypt woodland, open forest and mallee. Often found along rivers and in lightly wooded farmland. Feeds on the ground, predominantly on grass seed.	Potential habitat present Assessment of Significance applied
Eastern Bent-wing Bat ***Miniopterus schreibersii oceanensis***	V		Recorded on site	Occur in colonies in forest and woodland. Roost during the day in caves, old mines and occasionally buildings. Forage for insects above the tree canopy in well timbered valleys. Large aggregations of females gather each spring in specific nursery caves to raise young.	Recorded on site. Assessment of Significance applied
Eastern Cave Bat *Vespadelus troughtoni*	V		Not Recorded	Dry open forest and woodland near cliffs or rocky over hangs. Roosts in caves, overhangs and disused mine workings.	Habitat not suitable Not likely to occur
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V		Not recorded	Range of habitats including moist and dry sclerophyll forest and rainforest. Roosts in tree hollows in forests, isolated paddock trees and occasionally buildings. Generally forages within or just below the tree canopy.	Potential habitat present Assessment of Significance applied
Eastern Freetail Bat *Mormopterus norfolkensis*	V		Not recorded	Very little known. Roosts in tree hollows. Rare on New England Tablelands.	Not likely to occur
Eastern Long-eared Bat *Nyctophilus timoriensis*	V	V	Not recorded	Dry forest, woodland, mallee and other semi-arid or arid habitats. Roosts in tree hollows or under bark. Forages within and below the canopy. May occasionally forage on the ground.	Habitat not suitable Not likely to occur
Eastern Pygmy-possum *Cercatetus nanus*	V		Not recorded	Occurs in a range of vegetation types from wet and dry eucalypt forest, subalpine woodland, coastal Banksia woodland and wet heath. Feeds mostly on pollen and nectar from banksias, eucalypts and understorey plants. Shelters in small nests in tree hollows, tree stumps or under bark.	Habitat not suitable Outside of known range Not likely to occur

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Five-clawed Worm-skink *Anomalopus mackayi*	E	V	Not recorded	Usually occurs close to or on lower slopes of slight rises in grassy White Box woodland on moist black soils or and River Red Gum/Coolibah/Bimble Box Woodland on deep cracking loose clay soils. Lives in deep tunnels and deep soil cracks coming near to the surface under fallen timber and litter.	Habitat not suitable Not likely to occur
Freckled Duck *Stictonetta naevosa*	V		Not recorded	Permanent and temporary freshwater wetlands, swamps and open lakes. Waterbodies are usually shallow and well vegetated. Breed in densely vegetated swamps and flock to large permanent water bodies in times of drought. Feeds on water plants and invertebrates in shallow water.	Habitat not suitable Not likely to occur
Glossy Black-Cockatoo *Calyptorhynchus lathami*	V		Not recorded	Usually associated with stands of *Allocasuarina* in moist and dry eucalypt forest and woodlands. Reliant on *Allocasuarina* cones for food. Nests in hollows.	Habitat not suitable Not likely to occur
Greater Broad-nosed Bat *Scoteanax rueppellii*	V		Not recorded	Occurs in a variety of habitats including woodland, moist and dry sclerophyll forest and rainforest though it is most commonly found in tall wet forest. Roosts in tree hollows. Forages on the edges of cleared areas and in open woodland. Large flying insects are the primary food source. It is widespread on the escarpments of the New England Tablelands, however it is not known to occur at altitudes above 500 m.	Habitat not suitable Not likely to occur
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V		Not recorded	Dry open woodland with mature eucalypt trees, tall shrubs and groundcover of grasses and forbs. Also found in farmland with scattered trees.	Habitat not suitable Not likely to occur
Grey-headed Flying-Fox *Pteropus poliocephalus*	V	V	Not recorded	Roosts in conspicuous camps in lowland rainforest, swamp forest or riparian forest. Forages on fruit, nectar and pollen. Also visits orchards and gardens. Rarely recorded in the New England Bioregion.	Habitat not suitable Not likely to occur
Hoary Wattled Bat *Chalinolobus nigrogriseus*	V		Not recorded	Roosts in tree hollows and rock fissures. Feed on insects including flies, moths, crickets, cicadas, and ants and spiders. They catch some prey in flight but can also land and crawl quickly after non-flying prey.	Habitat on site not suitable. Potential habitat on TSR – Assessment of Significance applied
Hooded Robin *Melanodryas cucullata cucullata*	V		Not recorded	Often found in clearings or partly cleared areas adjoining a range of eucalypt woodlands, open forests and mallee and wattle shrublands.	Potential habitat present Assessment of Significance applied
Koala ***Phascolarctos cinereus***	V		Recorded on site	Woodlands and Open Forests and treed urban areas. Reliant of tree foliage, generally eucalyptus, for food. On the New England Tablelands the primary food tree species are *E. viminalis*, *E. tereticornis* and *E. amplifolia*. Only secondary food tree species occur on the study area (Section 6.4.2).	Potential habitat present Assessment of Significance applied
Large-footed Myotis *Myotis adversus*	V		Not recorded	This species is always associated with permanent, usually slow-flowing, water bodies. Feeds over water, catching prey both in the air and from the water surface. Roosts in caves, tunnels, tree hollows and dense vegetation.	Habitat not suitable Not likely to occur

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Little Lorikeet *Glossopsitta pusilla*	V		Not recorded on survey, known from TSR	Forages for nectar from eucalypt blossom, especially box and ironbark species. Breeding pairs occupy their nest sites throughout much of the year, near their food sources, and return regularly to defend and maintain them in the non-breeding season. Breeds in small cavities typically in living smooth-barked gums.	Habitat suitable Likely to occur
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	Not recorded	Roots in caves, in cliff crevices, old mine workings and disused Fairy Martin nests. Frequents low to mid elevation dry open forest and woodland close to roosting habitat.	Habitat not suitable Not likely to occur
Little Pied Bat *Chalinolobus picatus*	V		Not recorded	Dry habitats such as dry open forests, open woodlands, mulga woodlands, shrublands mallee and cypress pine forest. Occupied habitat is usually within flying distance of water. Roosts in mine shafts, caves, rock overhangs and, occasionally, tree hollows.	Habitat not suitable Not likely to occur
Long-nosed Potoroo *Potorous tridactylus*	V	V	Not recorded	Occurs in a range of plant communities including coastal heath and dry and wet sclerophyll forest. Requires thick ground cover of grasses, ferns, vines or shrubs.	Habitat not suitable Not likely to occur
Magpie Goose *Anseranas semipalmata*	V		Not recorded	Mainly found in shallow wetlands, including large swamps and dams, with dense growth of rushes or sedges and with permanent lagoons and grasslands nearby.	Habitat not suitable Not likely to occur
Masked Owl *Tyto novaehollandiae*	V		Not recorded	Dry eucalypt forest and woodland. Generally restricted to forests and woodlands although hunting in adjacent cleared areas does occur. Home ranges cover 500 to 1000 ha per pair. Nest in large tree hollows.	Habitat not suitable Not likely to occur
Painted Honeyeater *Grantiella picta*	V		Not recorded	Dry open forests and woodlands, particularly Box-Ironbark woodlands, with an abundant mistletoe fruit and nectar source	Habitat not suitable Not likely to occur
Painted Snipe *Rostratula australis*	V		Not recorded	Fringes of swamps, dams and marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Feed on worms, molluscs, insects and some vegetation.	Habitat not suitable Not likely to occur
Pale-headed Snake *Hoplocephalus bitorquatus*	V		Not recorded	Dry eucalypt forests and woodlands, cypress pine woodland and occasionally in moist eucalypt forest. Favours riparian areas in drier habitats. Shelters during the day under loose bark or in hollows. Mainly relies on tree frogs for food.	Habitat not suitable Not likely to occur
Powerful Owl *Ninox strenua*	V		Not recorded	Occupy large vegetated areas including woodlands, open forest, tall moist eucalypt forest and rainforest. Home ranges occupy over 1000 ha. Nests in large hollows in large eucalypts. Requires food source of gliders, possums and flying Foxes.	Habitat not suitable Not likely to occur

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Regent Honeyeater *Xanthomyza phrygia*	E	E	Not recorded	Dry open forest and woodlands in areas of low to moderate relief with abundant nectar producing eucalypts. Major food resources in the New England Bioregion are White Box, Yellow Box and Mugga Ironbark. Prefers Box-Ironbark woodlands	Potential habitat present Assessment of Significance applied
Rufous Bettong *Aepyprymnus rufescens*	V		Not recorded	Inhabit a variety of forests from tall moist eucalypt forests to open woodland with a sparse or grassy understorey	Marginal potential habitat present Not likely to occur
Star Finch *Neochmia ruficauda ruficauda*	E4	E	Not recorded	Sedentary inhabitants of grasslands or grassy woodlands near water, although the three most recent sightings have been in cleared, or even suburban, settings that have very few remnant trees. The finches build domed nests in patches of grass, reeds or low trees. Formerly occurred throughout eastern Australia from the Namoi Valley to Burdekin. Now confined to central Queensland.	Study area well outside known current distribution Not likely to occur
Speckled Warbler ***Pyrrholaemus sagittata***	V		Recorded on site	Eucalypt and cypress woodland with a grassy understorey and patches of shrubs. Speckled Warblers feed on the ground in pairs or trios and nest on the ground in grass tussocks and fallen timber.	Potential habitat present Assessment of Significance applied
Spotted-tailed Quoll *Dasyurus maculatus*	V	E	Not recorded	Undisturbed large remnant Woodlands and Open Forests. Tend to move along drainage lines and make dens in fallen hollow logs or among large rock outcrops.	Habitat not suitable Not likely to occur
Square tailed Kite *Lophoictinia isura*	V		Not recorded	Dry woodland and open forest. Prefers vegetation along major rivers and belts of trees in urban or semi-urban areas for hunting. Nests in large trees along water courses. Preys on bird nests in woodlands and open forests. Home ranges occupy at least 100 km^2.	Potential habitat present Assessment of Significance applied
Squirrel Glider *Petaurus norfolcencis*	V		Not recorded	Dry eucalypt forest and woodland. In inland areas they are predominantly found in box-ironbark woodlands and River Red Gum forest. They require abundant tree hollows for refuge and nest sites. May be restricted to stands mixed forest that contain winter flowering eucalypts or banksias that contribute to a reliable seasonal food supply.	Potential habitat present Assessment of Significance applied
Squatter Pigeon *Geophaps scripta*	E	V	Not recorded	Grassy woodlands and plains, preferring sandy areas close to water. Feed on the ground on seeds of grasses, herbs and shrubs.	Habitat not suitable Not likely to occur
Stripe-faced Dunnart *Sminthopsis macroura*	V		Not recorded	Native dry grasslands. Seem to prefer tussock grasslands and low dry shrublands, often along drainage lines. Shelter in cracks in soil, grass tussocks or logs during the day.	Habitat not suitable Not likely to occur
Superb Parrot *Polytelis swainsonii*	V	V	Not recorded	River Red Gum forest, eucalypt woodland, mallee and farmland with scattered trees. Feed mainly on grass seed and herbs, as well as fruit, buds flowers insects and grain. Requires tree hollows for nesting.	Habitat not suitable Not likely to occur

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Swift Parrot *Lathamus discolor*	E	E	Not recorded	Breeds in northern Tasmania during spring and summer. Disperses widely across south-eastern Australia during winter. Forages in woodland and riparian vegetation. Preferred food in northern NSW is nectar of winter flowering eucalypts, particularly Mugga Ironbark, Grey Box and White Box.	Habitat not suitable Not likely to occur
Turquoise Parrot *Neophema pulchella*	V		Not recorded	Eucalypt woodlands and open forests with a grassy ground cover or with a low understorey of shrubs. Commonly found on the edge of eucalypt woodlands adjoining clearings, or timbered ridges, and along creeks. Nests in hollows in trees, logs or posts.	Habitat not suitable Not likely to occur
Tusked Frog *Adelotus brevis*	E2		Not recorded	Rainforest, Wet sclerophyll forest, flooded grassland, puddles	Habitat not suitable Not likely to occur
Yellow-bellied Glider *Petaurus austalis*	V		Not recorded	Tall mature eucalypt forests. Nest in large tree hollows. Varied diet including nectar and pollen from winter flowering eucalypts, eucalypt sap.	Habitat not suitable Not likely to occur
Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*	V		Not recorded	Occupy a wide range of habitats. Roost in tree hollows. May be a seasonal migrant moving from northern to southern Australia in late summer and Autumn. Forages above canopy in wooded areas and lower in more open areas.	Potential habitat present Assessment of Significance applied

Of the threatened species considered in Table 6, 14 are considered to have suitable habitat represented on the study area. These species, and aspects of the habitat on site suitable for them, are as follows:

- Barking Owl: Foraging habitat in productive eucalypt woodland, e.g. Box Gum or riparian
- Black-Chinned Honeyeater: Eucalypt woodland
- Brown Treecreeper: Eucalypt woodland
- Diamond Firetail: Grassy eucalypt woodland. Recorded on site
- Eastern Bent-Wing Bat: Foraging habitat of eucalypt woodland
- Eastern False Pipistrelle: Foraging and roosting habitat of eucalypt woodland
- Hoary Wattled Bat: Foraging and roosting habitat of eucalypt forest and rainforest
- Hooded Robin: Foraging and breeding habitat of eucalypt woodland
- Koala: Foraging and breeding habitat of eucalypt woodland. Recorded on site
- Little Lorikeet: Foraging and breeding habitat of Box Gum and riparian gum woodland
- Regent Honeyeater: Marginal foraging habitat of eucalypt woodland
- Speckled Warbler: Breeding and foraging habitat of eucalypt grassy woodland with understorey of native shrubs. Recorded on site
- Square-Tailed Kite: Foraging habitat of eucalypt woodland canopy
- Squirrel Glider: Foraging habitat of eucalypt woodland, nests in small hollows
- Yellow-Bellied Sheathtail Bat: Foraging and roosting habitat above woodland canopy, tree hollows

Table 7 presents an evaluation and summary of habitat requirements of five (5) fauna species currently provisionally listed as threatened (Preliminary Determination: TSC Act – Vulnerable). They are known to occur in the New England Tableland Bioregion, and are considered to have potential habitat present on the study site. These species are those known to have distributions that include the study area or habitat requirements similar to that present within the study area or surrounding area.

The provisionally listed threatened species in Table 6 are considered to have suitable habitat represented on the study area. These species, and aspects of the habitat on the site suitable for them, are as follows:

- Flame Robin: Winter foraging habitat of eucalypt open woodland and grassland
- Little Eagle: Foraging and breeding habitat of eucalypt woodland. Recorded breeding on site.
- Scarlet Robin: Foraging and breeding habitat of eucalypt woodland. Recorded on site.
- Varied Sittella: Foraging and breeding habitat of eucalypt woodland. Recorded on site
- White-browed Woodswallow: Foraging and breeding habitat of eucalypt woodland

An assessment of significance (7-part test) of potential impacts of the proposed development on species listed under the TSC Act is presented in Appendix A. An assessment of potential impacts on matters of national significance (EPBC Act) is presented in Appendix B.

Table 7. Evaluation of provisionally threatened fauna (Preliminary Determination; TSC Act – Vulnerable) to Identify species with potential habitat on the study area.

Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct
(References: Cayley 1995, Debus 1998, Garnett 1993, Higgins & Peter 2002, Higgins *et al.* 2006, Marchant & Higgins 1993, NPWS 1998a, NPWS 2001a, NPWS 2001b, Simpson & Day 1993, Slater 1986).

Common Name	*TSC* Act	*EPBC* Act	Results of Fauna Survey	Habitat Required	Presence of suitable habitat
Flame Robin *Petroica phoenicea*	V		Not recorded	Breeds in high-altitude eucalypt woodland, winters in lower-altitude open woodland and grassland. Builds a nest of fibres in a fork or crevice.	Habitat suitable Likely to occur in winter
Little Eagle ***Hieraaetus morphnoides***	**V**		**Recorded**	**Breeds in open forests and woodlands, foraging habitat extends to open woodlands. Builds a stick nest in the canopy of a mature live eucalypt.**	**Habitat suitable** **Known to occur**
Scarlet Robin ***Petroica boodang***	**V**		**Recorded**	**Eucalypt open forest and woodland. Builds a nest of fibres in the fork of a live or dead branch in a live tree or tall shrub.**	**Habitat suitable** **Known to occur**
Varied Sittella ***Daphoenositta chrysoptera***	**V**		**Recorded**	**Eucalypt open forest and woodland. Forages on bark and dead banches in the tree canopy. Builds a nest of fibres in the upright fork of a dead branch in a live treetop.**	**Habitat suitable** **Known to occur**
White-browed Woodswallow *Artamus superciliosus*	V		Not recorded	Eucalypt open forest and woodland. Builds a nest of twigs in the fork or crevice of a tree or shrub	Habitat suitable Likely to occur

6.4 SEPP44 (Koala Habitat Protection) Assessment

6.4.1 Background Details

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline:

- by requiring the preparation of Plans of Management before development consent can be granted in relation to areas of core Koala habitat;
- by encouraging the identification of areas of core Koala habitat; and,
- by encouraging the inclusion of areas of core Koala habitat in environment protection zones.

Core Koala habitat means an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

Potential Koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 (feed tree species) constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. In the Northern Tablelands region Ribbon Gum *E. viminalis*, Forest Red Gum *E. tereticornis* and Cabbage Gum *E. amplifolia* are primary food tree species. Thirty-two (32) eucalypt species, mainly gums and boxes are recognized as secondary food tree species and 12 Stringybark species are recognised as supplementary food tree species (DECC 2008a; Table 8).

6.4.2 Koala Assessment

The Local Government Area of Armidale is listed in Schedule 1 of the Local Government Areas to which SEPP 44 applies, and is recognised as potential Koala habitat.

Of the list of scheduled Koala food trees within Koala Management Area No. 4 (Northern Tablelands; Table 8), none of the eucalypt trees on the Site are scheduled primary food trees.

Historically, there is one Koala sighting recorded in NPWS Wildlife Atlas about 2 km west of the study area on Waterfall Way.

Assessment of the Box Gum Woodland TSR as Koala Habitat

Of the 232 trees assessed within the 100 m wide corridor for the proposed access road through the TSR, 58% of the trees are secondary food trees (25% Blakely’s Red Gum, 26% Yellow Box, 2% Apple-Topped Box and 5% Narrow-Leaved Black Peppermint) and the remaining 42% are supplementary Koala feed trees (New England Stringybark).

One Koala was spotlighted in the Box Gum Woodland on the TSR during the fauna survey in March 2005. However, no evidence of Koala utilisation was found in the vicinity of the proposed landfill access route after an intensive search was conducted in September 2006. A follow-up search of the TSR, with a focus on the access route, was undertaken on the 23-24 November, 2009. The survey included a search for scats and scratches and 2.5 hr of spotlighting. No evidence of Koalas within the TSR was recorded during this search in 2009.

According to *Appendix B: Categories of Koala Habitat* of the *NSW Koala Recovery Plan* (DECC 2008a) the TSR is considered *Secondary Habitat (Class A)* as secondary food tree species alone comprise at least 50% of the overstorey trees and primary Koala food tree species are absent. However, no evidence of Koalas was recorded in the recent survey of the TSR suggesting the site is not currently in use as Koala habitat. **The site does not contain any**

primary food trees, thus the site would not be considered core or potential Koala habitat under *State Environmental Planning Policy No 44 – Koala Habitat Protection* (SEPP 44).

Assessment of the Stringybark Woodland as Koala Habitat

Most of the trees (>95%) of the trees in the Stringybark Woodland are the supplementary Koala food tree species: New England Stringybark. A few of the trees are secondary food tree species, including four Yellow Box and one Blakely's Red Gum. Under two Yellow Box, one Blakely's Red Gum and one Stringybark Koala scats were found (Table 9) during a search on 23 November 2009. Scratches were also found on the Red Gum and one of the Yellow Box trees. These signs indicate that the woodland has been used by Koalas recently, but the lack of primary or secondary food trees in the woodland suggest it is not core Koala habitat. No Koalas were recorded during at 2.5 hr spotlighting survey on 24 November 2009.

According to the *NSW Koala Recovery Plan* (DECC 2008a) the Stringybark Woodland *may* be considered *Secondary Habitat (Class C),* which describes a site with supplementary food tree species and <30% secondary food tree species. However, the number of secondary food tree species is so low that the site could be considered to not be suitable Koala habitat at all. **The site does not contain any primary food trees, thus the site would not be considered core or potential Koala habitat under *State Environmental Planning Policy No 44 – Koala Habitat Protection* (SEPP 44).**

Nonetheless, Yellow Box tree number 3 appears to be used significantly by Koalas. As this tree is on the border of the development (Figure 7; Table 8) it should be retained. This tree is very large and may also be a suitable tree for the Little Eagles to establish a new nest site.

Table 8. Location and signs of Koalas at the site in November 2009 (GDA 94, Zone 56 J)

Tree Number	Tree Species	Northing*	Easting*	No of Scats	Other signs
1	Blakely's Red Gum	6618968	383224	74	scratches
2	Yellow Box	6618998	383203	31	
3	Yellow Box	6618653	383230	180	scratches
4	NE Stringybark	6618832	383427	18	

* Coordinates accurate to ±10 m.

Table 9. Primary, secondary and Stringybarks/supplementary species of Koala food trees recorded within the Koala Management Area No. 4 (Northern Tablelands).

Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct

Common Name	**Scientific Name**
Primary Food Tree Species	
Ribbon Gum	*Eucalyptus viminalis*
Forest Red Gum	*E. tereticornis*
Cabbage Gum	*E. amplifolia*
Secondary Food Tree Species	
	E. interstans
	E. retinens
	E.volcanica
Apple-topped Box	***E. bridgesiana***
Blakely's Red Gum	***E. blakelyi***
Brittle Gum	*E. michaeliana*
Brittle Gum	*E. praecox*
Brittle Gum	*E. mannifera*
Broad-leaved Sally	*E. camphora*
Bundy	*E. goniocalyx*
Candlebark	*E. rubida*
Dwyer's Red Gum	*E. dwyeri*
Eurabbie	*E. bicostata*
Forest Ribbon Gum	*E. nobilis*
Fuzzy Box	*E. conica*
Grey Box	*E. moluccana*
Large-flowered Bundy	*E. nortonii*
Monkey Gum	*E. cypellocarpa*
Moonbi Apple Box	*E. malacoxylon*
Mountain Gum	*E. dalrympleana*
Mountain Mahogany	*E. notabilis*
Narrow-leaved Black Peppermint	***E. nicholii***
New England Peppermint	*E. nova-anglica*
Orange Gum	*E. prava*
Red Box	*E. polyanthemos*
Snow Gum	*E. pauciflora*
Tenterfield Woolybutt	*E. banksia*
Tumbledown Gum	*E. dealbata*
Wattle-leaved Peppermint	*E. acaciiformis*
White Box	*E. albens*
White-topped Box	*E. quadrangulata*
Yellow Box	***E. melliodora***
Stringybarks/Supplementary Species	
	E. stannicola
	E. williamsiana
	E. subtilior
	E. conjuncta
Broad-leaved Stringybark	***E. caliginosa***
Diehard Stringybark	*E. cameronii*
McKie's Stringybark	*E. mckienana*
Privet-leaved Stringybark	*E. ligustrina*
Red Stringybark	*E. macrorhyncha*
Silver-topped Stringybark	*E. laevopinea*
Yellow Stringybark	*E. muelleriana*
Youman's Stringybark	*E. youmanii*

6.5 Endangered Populations

Review of Part 2 of Schedule 1 of the TSC Act identified an endangered population of the tusked frog (*Adelotus brevis*) listed for the New England Bioregion.

Historically, tusked frogs were recorded in most parts of the New England Tableland Bioregion and west in the Nandewar Bioregion. Despite considerable survey effort in the past decade, no records are known from either Bioregion since 1976, with the exception of one record from 1992 at Riamukka to the extreme south of the New England Tablelands. Two records from 1997 are known from just outside the New England Tablelands, approximately 25 km south-east of Dundee (NPWS 2004). The Tusked Frog was not found to occur at the study area and the proposed development is not likely to impact on this population.

6.6 EPBC Act Migratory Species

Migratory species listed under the EPBC Act are a matter of national environmental significance under the EPBC Act's assessment and approval provisions. Listed migratory species include species listed in:

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA); and
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).
- Listed migratory species also include any native species identified in an international agreement approved by the Commonwealth Environment Minister. The Minister may approve an international agreement for this purpose if satisfied that it is an agreement relevant to the conservation of migratory species.

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species.

Review of the Protected Matters Search Tool indicated that nine (9) Migratory Species are likely to occur within a 20 km radius of the study area and 13 Listed Marine Species (some of these species are also listed as migratory or threatened species). These species, and an assessment of study area as potential habitat for these species, are presented in Table 10.

Table 10. EPBC migratory and listed marine species that may occur within a twenty kilometre radius of the study area.

Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct

Common Name	Relevant Conservation Status	Results of Survey	Habitat Required	Presence of suitable habitat
White-bellied Sea-Eagle *Haliaeetus leucogaster*		Not recorded	Large rivers, fresh and saline lakes, reservoirs, coastal seas, islands.	Habitat not suitable Not likely to occur
White-throated Needletail ***Hirundapus caudacutus***		**Recorded on site (TSR)**	**Aerial, mainly in Eastern Australia usually over coastal and mountain regions.**	**Potential habitat on site** **Known to occur**
Black-faced Monarch *Monarcha melanopsis*		Not recorded	Rainforests, eucalypt forests and coastal scrubs.	Habitat not suitable Not likely to occur
Spectacled Monarch *Monarcha trivirgatus*		Not recorded	Rainforests, mangroves and wet sclerophyll forests	Habitat not suitable Not likely to occur
Satin Flycatcher *Myiagra cyanoleuca*		Not recorded	Tall and medium open forests often at heights.	Habitat not suitable Not likely to occur
Rufous Fantail *Rhipidura rufifrons*		Not recorded	Undergrowth of forest gullies, and around swamps	Habitat not suitable Not likely to occur
Regent Honeyeater *Xanthomyza phrygia*	E	Not recorded	Dry open forest and woodlands Major food resources in the New England Tableland Bioregion are White Box, Yellow Box and Mugga Ironbark. Prefers Box-Ironbark Woodlands	Potential habitat on site Likely to occur
Lathams Snipe/Japanese Snipe *Gallinago hardwickii*		Not recorded	Wetland grasses, open wooded swamps.	Habitat not suitable Not likely to occur
Painted Snipe *Rostratula benghalensis s. lat.*	E	Not recorded	Temporary or infrequently filled freshwater wetlands	Habitat not suitable Not likely to occur
Fork-tailed Swift Apus pacificus		Not recorded	Aerial, usually over coastal and mountain regions.	Potential habitat on site Likely to occur
White Egret *Ardea alba*		Not recorded	Cool temperate to tropical wetlands, marshes, swamps, seashores, lake margins, sluggish rivers, estuaries, mud flats, ponds, also irrigated lands & rice paddocks.	Potential habitat on site Likely to occur
Cattle Egret *Ardea ibis*		Not recorded	Prefer pasture among grazing stock and are occasionally seen in shallow wetlands	Potential habitat on site Likely to occur
Rainbow Bee-eater *Merops ornatus*		Not recorded	Common in most habitats of Australia, except dense forests	Potential habitat on site Likely to occur

6.7 Threatened Ecological Communities

Eight (8) threatened ecological communities, listed under Part 3 of Schedule 1 of the TSC Act and Schedule 2 of the EPBC Act, that occur in the New England Bioregion are described in Table 11. Of these, only the Box Gum Woodland occurs at the study site.

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: white box *Eucalyptus albens*, Yellow Box *E. melliodora* and Blakely's Red Gum *E. blakelyi*. Intact sites contain a high diversity of plant species, including any of the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a high diversity of herbs. The community also includes a range of mammal, bird, reptile, frog and invertebrate fauna species. Intact stands that contain diverse upper and mid-storeys and groundlayers are rare (NPWS 2002c).

The Box Gum Woodland on the Gara TSR is relatively intact with a high diversity of plant species and has been managed as a TSR for over 90 years (Figure 4). This community is listed as endangered under the TSC Act, and as critically endangered under the EPBC Act. Steps followed in the TSC and EPBC identification guides to satisfy the criteria for inclusion of Box Gum Woodland on the TSR in the listed ecological communities are presented in Appendix I and Appendix J.

Sites where there is some regeneration potential are also part of the EEC. Thus the cleared grassland, with predominantly native grasses and forbs is also included in the Box–Gum Woodland EEC under the TSC Act (Figure 4). This grassland is not included in the EPBC listed CE Box–Gum Woodland as it does not meet the criterion of a sufficient number of non-grass understorey native species.

An assessment of significance (7-part test) under the TSC Act (Appendix A) and the EPBC Act (Appendix B) examining the potential impacts of the proposed development on Box Gum Woodland has been completed.

Table 11. Threatened Ecological Communities in the New England Tableland Bioregion (DEH 2008, NPWS 2006)
Shaded = suitable habitat on site; bold = recorded on site.
E = Endangered, V = Vulnerable, E2 = Endangered Population, E4 = Presumed Extinct

Community	Form	Description	Recorded on site?
Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest	Low closed forest	Characterised by large hummocks of Sphagnum Moss under a low dense rainforest canopy. Common species include *Elaeocarpus holopealus*, *Quintinia sieberi*, *Banksia integrifolia* and *Leptospermum polygalifolium* ssp. *montanum*. Found along sheltered creeklines in Ben Halls Gap National Park.	No
McKies Stringybark/Blackbutt open forest	Open Forest	Found on lateritic soils in low lying areas, on hillslopes open depressions in the Gilgai area of Northern NSW. Open forest characteristic species includes *Eucalyptus andrewsii*, *Eucalyptus mckieana* and *Callitris endlicheri*. Extensive species assemblage.	No
Howell Shrublands	Shrubland, grassland, low open woodland.	Usually dominated by low shrubs, particularly *Babingtonia densifolia* and *Homoranthus prolixus*. Occurs on granitic outcrops. Extensive species assemblage. Confined to areas of extensive granite outcropping between Inverell and Manilla.	No
Upland Wetlands of the Drainage Divide of the New England Tablelands.	Wetland	Shallow-temporary to near-permanent wetlands naturally restricted to the higher altitudes (above about 900m) associated with the Great Dividing Range in northern NSW. Vegetation within the ecological community frequently consists of sedges, rushes and aquatic plants in a closed to mid-dense sedgeland, herbland or grassland community on the shores of open water or extending across shallow or dry wetland beds.	No
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions	Wetland	Plant community associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. Typically has an open to very sparse layer of shrubs, 1-5 m tall, including species of *Baeckea*, *Callistemon* and *Leptospermum*. Species of *Epacris* and *Hakea microcarpa* are also common shrubs.	No
New England Peppermint Woodland on sediments in the New England Tableland Bioregion	Woodland/ Open Forest	Dominated by trees of *Eucalyptus nova-anglica* and occasionally *E. dalrympleana* subsp. *heptantha*, usually 8-20 metres tall. There are few shrubs present, and none listed as common. Ground cover is usually dense with *Asperula conferta*, *Poa sieberiana*, *Themeda australis*, *Juncus filicaulis*, *Dichondra repens*, *Carex inversa*, *Rumex brownii*, *Acaena ovina* and *Desmodium varians* common.	No. *Eucalyptus nova-anglica* not recorded on site.

Community	Form	Description	Recorded on site?
Box Gum Woodland (TSC & EPBC) White Box, Yellow Box, Blakely's Red Gum Woodland (TSC) White Box, Yellow Box, Blakely's Red Gum Woodlands and Derived Native Grasslands (EPBC)	Grassy Woodland or Open Forest	Found on relatively fertile soils of the Tablelands and Western Slopes of NSW. Dominant trees are *Eucalyptus albens, E. melliodora* and *E. blakelyi*. In some locations the tree overstorey may be absent due to past clearing. Shrubs are generally absent or rare. Groundcover dominated by herbaceous species. Woodlands dominated by *E. albens* are common in the western slopes. *E. melliodora* dominate on the tablelands. *E. melliodora* is often found lower in the landscape on areas of higher soil moisture. The area of this community on the subject site is less than 5% of that in the adjoining Gara TSR, and less than 1% of that occurring in the region.	Yes. The Box Gum Woodland in the TSR beside Waterfall Way meets the definition of Box Gum Woodland for both TSC and EPBC Cleared grassland bordering the TSR is included in the Box Gum Woodland community for the TSC listing but not meet the criteria for EPBC listing The Stringybark Woodland in the southern part of the site contains the occasional Yellow Box tree and a few individual Blakely's Red Gums. However, the complete dominance of Stringybark trees means this community is not classified as Box Gum Woodland.
Ribbon Gum – Mountain Gum – Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	Grassy Woodland or Open Forest	Common overstorey species include *Eucalyptus viminalis* (Ribbon Gum), *E. dalrympleana subsp. Heptantha* (Mountain Gum), *E. pauciflora* (Snow Gum or White Sallee) and occasionally *E. stellulata* (Black Sallee). The understorey comprises a sparse layer of shrubs including *Acacia dealbata, Pultenaea microphylla* and *Pimelea linifolia* and a dense to very dense grassy ground cover dominated by *Poa sieberiana var. sieberiana, P. labillardieri var. labillardieri, Themeda australis* and *Elymus scaber*. This community may co-occur with White Box Yellow Box Blakely's Red Gum Woodland. These two Endangered Ecological Communities may intergrade where they adjoin and in intermediate habitats such as occur in the vicinity of Armidale. All intermediate assemblages are collectively included within the two communities.	No. The defining overstorey species (*E. viminalis, E. dalrympleana, E. pauciflora* or *E. stellulata*) were not recorded on the study area.

6.8 Key Threatening Processes

In order to evaluate actual or potential threats it is important to consider past, current and future threats, taking into account how and where such threats may impact on threatened species known or likely to occur in the study area.

Threatening processes listed as Key Threatening Processes under Schedule 3 of the TSC Act and under the EPBC Act which are relevant to the landfill site are listed in Table 12.

Table 12. Key threatening processes listed under the TSC Act and EPBC Act (*)

Threatening Process	Act	Likely to occur on site	Proposal may contribute
*Clearing of native vegetation/ Land clearance	TSC/EPBC	yes	yes
Loss of hollow bearing trees	TSC	yes	yes
Removal of dead wood and dead trees	TSC	yes	no
*Anthropogenic climate change/ Loss of climatic habitat caused by anthropogenic emission of greenhouse gases	TSC/EPBC	yes	yes
*Competition and grazing (land degradation) by the feral European Rabbit, *Oryctolagus cuniculus*	TSC/EPBC	yes	no
Predation by the European Red Fox *Vulpes vulpes*	TSC	yes	no
Competition from feral Honey Bees, *Apis mellifera* L.	TSC	yes	no

The disturbance history of the site indicates that a number of threatening processes have occurred in the past. Some of these processes currently occur on the subject site. These include clearing of native vegetation, competition and grazing by the feral European Rabbit, predation by the European red Fox, and removal of dead wood and dead trees. The proposed development will contribute to clearing of native vegetation, loss of hollow bearing trees, and may potentially contribute to human-caused climate change.

6.8.1 Clearing of Native Vegetation

Clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. The definition of clearing does not preclude management activities to control exotic species, or native species growing outside their natural geographic range.

Native Vegetation means any of the following types of indigenous vegetation: trees, understorey plants, groundcover, and plants occurring in a wetland. This definition of native vegetation is consistent with the definition in the *Native Vegetation Act 2003*.

The Determination applies to clearing as a process, regardless of the species, populations and ecological communities affected in a particular instance. Clearing of any area of native vegetation, including areas less than 2 ha in extent, may have significant impacts on biological diversity (NPWS 2001c).

Destruction of habitat is the major cause of loss of biological diversity. For species of restricted distribution, clearing of native vegetation may result in total extinction, for more widespread species there may be loss of local genotypes.

Clearing has been identified as a threat to a number of species, communities and populations listed under the TSC Act and could cause species, populations or ecological communities that are not threatened to become threatened.

Remnants of the EEC, Box Gum Woodland are subject to varying degrees of threat that jeopardise their viability. These threats include: further clearing (for cropping, pasture improvement or other development); deterioration of remnant condition (caused by firewood cutting, increased livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance and increased nutrient loads); degradation of the landscape in which remnants occur (including soil acidification, salinity, and loss of connectivity between remnants).

The proposed development will entail clearing of approximately 20 ha:

- It is proposed to clear 12.7 ha of Stringybark Woodland for the landfill footprint. This woodland is in moderate condition and is currently subject to grazing, weed and pest impacts. The Stringybark Woodland has been disturbed by extensive clearing of regrowth 10 to 20 years ago.
- It is proposed to clear 0.6 ha of Box Gum Woodland in the Gara TSR. The area proposed to be cleared has been partially cleared in the past for an access easement prior to the realignment of the Waterfall Way.
- It is proposed to clear 6.5 ha of grassland and 0.5 ha of sedgeland. This community on the subject site is in low to moderate condition and is currently subject to grazing impacts. Approximately 3.3 ha of this grassland bordering the TSR may be considered very degraded Box Gum Woodland.

The implementation of proposed mitigation measures set out in Section 7 will help reduce negative impacts of clearing and loss of habitat on native plants and animals in the study area.

6.8.2 Loss of hollow-bearing trees

Hollow cavities are characteristic of older, mature to over-mature trees either living or dead and may develop in the trunk and branches of trees as a result of wind breakage, lighting strikes, fire and/or following the consumption and decay of internal heartwood by fungi and invertebrates, primarily termites. Hollows occur primarily in old eucalyptus trees. The presence, abundance and size of hollows are positively correlated with tree trunk diameter, which is an index of age. Hollows with large internal dimensions are the rarest and occur predominantly in large old trees >220 years old. Larger, older trees also provide a greater density of hollows per tree. As such, large old hollow-bearing trees are more valuable to hollow-using fauna than younger hollow-bearing trees, which are important as a future resource (DECCW 2007).

The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics. To maintain an ongoing supply of large hollow bearing trees old growth forests should be left intact and dead trees, stags and stumps should be left standing whenever possible.

Twenty-one (21) threatened species recorded in databases within 10 km of the site use hollows for nesting or roosting; including eight (8) birds, 13 mammals and one reptile (Table 13; DECCW 2007). Of these, seven (7) species have suitable habitat on the site, as indicated in Table 6, but none were recorded on the site.

Table 13. List of hollow based species recorded in databases within 10 km of the site

Scientific Name	Common Name	Status (TSC Act)	Presence of Suitable Habitat
Birds			
Calyptorhynchus lathami	Glossy Black-cockatoo	Vulnerable	No
Climacteris picumnus picumnus	Brown Treecreeper (eastern subsp.)	Vulnerable	Yes. Assessment of significance applied
Glossopsitta pusilla	Little Lorikeet	Vulnerable	Yes. Assessment of significance applied
Neophema pulchella	Turquoise Parrot	Vulnerable	No
Ninox connivens	Barking Owl	Vulnerable	Potential foraging habitat Assessment of significance applied
Ninox strenua	Powerful Owl	Vulnerable	No
Polytelis swainsonii	Superb Parrot	Vulnerable	No
Tyto novaehollandiae	Masked Owl	Vulnerable	No
Mammals			
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable	No
Chalinolobus nigrogriseus	Hoary Wattled Bat	Vulnerable	Yes. Assessment of significance applied
Chalinolobus picatus	Little Pied Bat	Vulnerable	No
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	No
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable	Yes. Assessment of significance applied
Mormopterus norfolkensis	Eastern Freetail-bat	Vulnerable	No
Myotis adversus	Large-footed Myotis	Vulnerable	No
Nyctophilus bifax	Eastern Long-eared Bat	Vulnerable	No
Petaurus australis	Yellow-bellied Glider	Vulnerable	No
Petaurus norfolcensis	Squirrel Glider	Vulnerable	Yes. Assessment of significance applied
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	No
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Yes. Assessment of significance applied
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	No
Reptiles			
Hoplocephalus bitorquatus	Pale-headed Snake	Vulnerable	No

Few hollow bearing trees occur within the Stringybark Woodland at the landfill site. However, large stumps, either intact, or in piles of dead timber, would provide hollows for some species, including owlet-nightjars and some of the hollow nesting parrots. When the timber is redistributed at this site, it is recommended that these stumps are retained in the offset area and that at least some of these are position in an upright position to allow for use by hollow using birds.

Hollows are very abundant in the Box Gum Woodland within the TSR and many will be lost during construction of the offset road. Some of these hollows may be reattached to mature trees elsewhere in the TSR for use by birds, bats and arboreal mammals. However, the abundance of hollows elsewhere within the TSR suggests there will not be a substantial shortage in the woodland.

6.8.3 Removal of dead wood and dead trees

The “removal of dead wood and dead trees” includes: the removal of forest and woodland waste left after timber harvesting, collecting fallen timber for firewood, burning on site, mulching on site, the removal of fallen branches and litter as general tidying up, and the removal of standing dead trees.

Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals and provided foraging area for many species of birds), disruption of ecosystem process and soil erosion.

Dead trees and fallen logs (left in situ) in the TSR enhance the habitat value in the Box Gum Woodland community. However, unmanaged log piles in the Stringybark Woodland provide above-ground harbour for pests and weeds. Most of the timber in the large log piles has little contact with the soil surface. Such timber remains drier and takes longer to breakdown than logs lying on the ground. The relocation of large logs (>20 cm diameter) from these piles, placed flat on the ground, could enhance the habitat value conservation restoration/revegetation areas elsewhere on the site. Removing large, hollow stumps from the piles and repositioning them in an upright position elsewhere on the site could provide important nesting habitat for many species of birds.

6.8.4 Anthropogenic climate change

This threat imposed by climate change consists of “reductions in the bioclimatic range within which a given species or ecological community exists due to changes in the climatic habitat as a result of anthropogenic climate change” (DECCW 2009). The categories of human-induced activities are energy, industrial processes, solvent and other product use, agriculture land use change and forestry, and waste. The landfill in itself would have a minor impact on climate change. Waste will not be burnt on site.

None of the species in NSW that are listed to be most at risk due to climate change (DECCW 2009) have been recorded in the local area.

6.8.5 Competition and grazing by the feral European Rabbit

Rabbits, *Oryctolagus cuniculus*, have spread over most of the southern two thirds of Australia and now occupy approximately 4.5 million km^2.

Grazing and burrowing by Rabbits can cause massive erosion problems, reduce recruitment and survival of native plants, and alter entire landscapes. Rabbits also threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators, such as Foxes. In addition, Rabbits may have significant impacts on Aboriginal and historic cultural heritage. For example, overgrazing by Rabbits has exacerbated soil erosion in Mungo and Kinchega national parks, exposing culturally significant sites such as Aboriginal burial grounds.

Threatened species that suffer in dietary competition with Rabbits that have been recorded within 20 km of the site include the brush-tailed rock-wallaby *Petrogale penicillata*.

Grazing by Rabbits has reduced the survival and recruitment of several species of threatened plants. These include *Acacia carneorum, Grevillea kennedyana, Cynanchum elegans, Thesium australe* and *Lepidium hyssopifolium*.

Large numbers of Rabbits were observed using the numerous large log piles in the Stringybark Woodland. The soil in the southern section of the study area is shallow and it is likely that Rabbits are not able to dig very extensive burrows on this site. Surface harbour, such as log piles and briars allows a high proportion of Rabbits to remain sheltered above ground. Under these conditions Rabbit densities can increase and Rabbits can survive warren ripping or fumigation. Rabbits survive in the surface refuge and recolonise treated areas by re-opening warrens or digging new ones.

Ripping of warrens may not be effective in the Stringybark Woodland and therefore habitat modification and Rabbit-proof fencing may be more suitable techniques for Rabbit control. Removal of surface refuge greatly enhances the efficiency and effectiveness of control programs and slows recolonisation. This may be achieved through measures such as dismantling existing log piles and removing Blackberry (*Rubus spp*.) thickets. The potential adverse impacts of feral animal control measures on native species and their habitats needs to be considered by utilising an integrated feral animal control and wildlife management approach.

6.8.6 Predation by the European red Fox (Vulpes vulpes)

Foxes are an adaptable and elusive predator common in rural and urban areas throughout southern Australia. They do not appear to favour any particular habitat and the main determinants of their population size and distribution appear to be food supply, disturbance of natural habitats and refuge availability.

Since their introduction into Australia in the 1870s, Foxes have contributed to severe declines and extinctions of a suite of native fauna, particularly among medium-sized (450-5000 g) ground-dwelling and semi-arboreal mammals, ground-nesting birds and freshwater turtles. Recent experimental studies have shown that predation by Foxes continues to threaten remnant populations of many of these species (NPWS 2005b).

Foxes were observed in the Stringybark Woodland on the proposed landfill site. Two threatened ground foraging bird species (Speckled Warbler and Diamond Firetail Finch) were observed in this habitat. The Speckled Warbler which nests on the ground is at risk of predation by Foxes. Log piles provide shelter for both Rabbits and Foxes. The large numbers of Rabbits observed are likely to support large numbers of Foxes on the site.

6.8.7 Competition from feral Honey Bees (Apis mellifera L.)

Feral honeybees are introduced bees which originally escaped from hives and have subsequently established in the wild, usually in tree hollows, reducing the number of hollows available for native animals to breed and shelter. This is of particular concern for species which are threatened (Ambrose 1982). In one study on sugar gliders the researchers found that 30 of the 59 artificial nest boxes they erected were occupied by honeybees (Suckling and Goldstraw 1989). Honeybees also compete with native fauna for floral resources, such as pollen and nectar. Nectar and pollen are an important food resource for thousands of native animals including birds, arboreal marsupials, and many invertebrates, including more than 2000 species of native bees (Pyke 1990).

Threatened species that have been recorded in the local area (within 10 km of the site) which are likely to be affected by competition from honeybees for hollows include the brush-tailed phascogale (*Phascogale tapoatafa*), squirrel glider (*Petaurus norfolcensis*), yellow-bellied glider (*Petaurus australis*), glossy black cockatoo (*Calyptorhynchus lathami*), and superb parrot (*Polytelis swainsonii*; DECCW 2008). Populations of protected species that may become threatened in the local include the Common Brushtail Possum (*T. vulpecular*) and sugar glider (*Petaurus breviceps*; DECCW 2008). Of these species the squirrel glider is the only threatened species with suitable habitat present at the site and it was not recorded on-site. The brushtail possum and the sugar glider were both recorded on-site. The brushtail possum was recorded in very high numbers within the TSR (18 individuals and 2 young on 24 November 2009).

Hollow nesting birds, including many species of owls and parrots (e.g. Little Lorikeet) will be affected by use of hollows by feral Honey Bees. Although, no hives were observed, efforts to control feral honeybees at the site through fumigation should be undertaken.

6.9 Recovery Actions

DECCW has developed a Priority Action Statement (PAS; DECC 2007) that includes all detailed recovery and threat abatement actions for threatened species in NSW. Priority actions are the specific, practical things that must be done to recover a threatened species, population or ecological community. A number of priority actions have been identified to help recover the threatened species known to occur in the study area. It is recommended that Council adopt these Actions, to the extent practicable or relevant, in the offset areas as part of the CEMP and OEMP.

Box Gum Woodland

Threats

- Clearing, degradation and fragmentation of remnants for agricultural, forestry, infrastructure and residential development (direct impact due to the landfill);
- Continuous heavy grazing and trampling of remnants by grazing stock, resulting in losses of plant species (simplification of the understorey and groundlayer and suppression of overstorey), erosion and other soil changes (including increased nutrient status) (impact ameliorated by stock removal under landfill management);
- Invasion of remnants by non-native plant species, including noxious weeds, pasture species and environmental weeds, garden escapes, olives and pines (potential indirect impact due to the landfill);
- Invasion of remnants by feral animals resulting in the loss or modification of habitat (indirect impact due to the landfill);
- Disturbance and clearance of remnants during road, rail and infrastructure maintenance and upgrades (indirect, marginal impact due to landfill);
- Harvesting of firewood (either living , standing dead, or fallen timber) (indirect impact in TSR due to landfill access route); and
- Collection of on-ground woody debris in the guise of a 'clean-up' (potential indirect impact due to the landfill).

Recommended recovery actions

- Undertake control of Rabbits, hares, Foxes, pigs and goats (using methods that do not disturb the native plants and animals of the remnant);
- Do not harvest firewood from remnants (this includes living or standing dead trees and fallen material);
- Manage stock to reduce grazing pressure in high quality remnants (i.e. those with high flora diversity or fauna habitat);

- Encourage regeneration by fencing remnants, controlling stock grazing and undertaking supplementary planting, if necessary;
- Erect on-site markers to alert maintenance staff to the presence of a high quality remnant or a population of a threatened species;
- Undertake weed control (taking care to spray or dig out only target species);
- Protect all sites from further clearing and disturbance;
- Ensure remnants remain connected or linked to each other; in cases where remnants have lost connective links, re-establish them by revegetating sites to act as stepping stones for fauna, and flora (pollen and seed dispersal); and
- Mark remnants on maps (of the property, region, etc.) and use these maps to plan activities (e.g. remnant protection, rehabilitation or road, rail and infrastructure maintenance work).

Eastern Bent-Wing Bat

Threats

- Damage to or disturbance of roosting caves, particularly during winter or breeding (not applicable to the landfill);
- Loss of foraging habitat (direct impact due to the landfill);
- Application of pesticides in or adjacent to foraging areas (not applicable to the landfill); and
- Predation by feral Cats and Foxes (indirect impact due to the landfill).

Recommended recovery actions

- Control Foxes and feral Cats around roosting sites, particularly maternity caves;
- Retain native vegetation around roost sites, particularly within 300 m of maternity caves;
- Minimise the use of pesticides in foraging areas;
- Protect roost sites from damage or disturbance; and
- Provide roost sites within offset area., if practicable (roost sites are hollows in trees)

Little Eagle

Threats

- Clearing and degradation of foraging and breeding habitat (direct impact of the landfill); and
- Possible secondary poisoning from Pindone baiting of Rabbits (potential indirect impact of the landfill if Pindone sued to control Rabbits).

Recommended recovery actions

- Clear the development site in stages, gradually approaching the nest tree before the breeding season (August-January).
- Avoid highly disturbing activity (e.g. heavy machinery) within 100 m of the nest in the breeding season (August-January).
- Retain the 2009 nest tree and a surrounding 50 m buffer in the offset zone.
- If retention of the nest tree is impracticable, include a tree with similar characteristics (e.g. tall Yellow Box with mistletoes) in the offset zone. A suitable tree is the Yellow Box where Koala scats were found near the southern boundary of the landfill footprint at 56J 383230 m E, 6618653 m S (Figure 7). This tree should be managed in the same way as suggested above for the existing nest tree.

- Remove the nest tree (if necessary) in the non-breeding season (February-July).
- Control Rabbits by means other than baiting with Pindone (e.g. 1080 baiting, fumigating and ripping of warrens, dispersion of log piles, destruction of Blackberry).

Little Lorikeet

Threats

- Loss of large flowering eucalypts, especially boxes and gums (direct, though limited, impact due to the landfill);
- Loss of hollow trees (direct, though limited, impact due to the landfill); and
- Competition by feral bees for tree hollows (not applicable to the landfill).

Recommended recovery actions

- Protect hollow-bearing trees and younger mature trees to ensure replacement of older trees;
- Protect remnant woodland and open forest, and in particular, large flowering eucalypts;
- Regenerate and replant local flora species to maintain breeding and foraging habitat; and
- Control feral bees by fumigating hives in tree hollows.

Speckled Warbler, Varied Sittella, Scarlet Robin

Threats

- Clearance of remnant grassy woodland habitat for paddock management reasons and for firewood (direct impact due to the landfill);
- Poor regeneration of grassy woodland habitats (impact ameliorated by stock removal under landfill management);
- Modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, heavy grazing and compaction by stock and frequent fire (not applicable);
- Fragmentation of habitat through woodland clearance for residential, agricultural and other developments (initial direct impact due to the landfill, but progressively reversed under landfill management); and
- Nest failure due to predation by native and non-native birds, Cats, Dogs and Foxes particularly in fragmented and degraded habitats (indirect impact due to the landfill).

Recommended recovery actions

- Raise landowners' awareness about the presence of these species and provide information on how their management actions will affect the species;
- Keep domestic dogs and Cats indoors at night. De-sex domestic dogs and Cats. Assess the appropriateness of dog and cat ownership in new subdivisions;
- Undertake Fox and feral cat control programs;
- NPWS should be consulted when planning development to minimise impact on populations;
- Searches for the species should be conducted in suitable habitat in proposed development areas;
- Retain existing vegetation along roadsides, in paddocks and remnant stands of native trees;
- Retain dead timber on the ground in open woodland areas;
- Limit firewood collection;
- Fence suitable woodland habitats, particularly those with unimproved pasture and an

intact native ground plant layer;

- Encourage regeneration of habitat by fencing remnant stands;
- Increase the size of existing remnants, plant trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants; and
- Assess the importance of linkages for the species between ecological resources across the broader landscape.

Diamond Firetail Finch - Recovery

Threats

- Clearing and fragmentation of woodland, open forest, grassland and mallee habitat for agriculture and residential development, and firewood collection(direct impact due to the landfill);
- Poor regeneration of open forest and woodland habitats (impact ameliorated by stock removal under landfill management);
- Invasion of weeds, resulting in the loss of important food plants (potential indirect impact due to the landfill);
- Modification and destruction of ground- and shrub layers within habitat through removal of native plants, litter and fallen timber, introduction of exotic pasture grasses; heavy grazing and compaction by stock, and frequent fire (not applicable to the landfill);
- Predation of eggs and nestlings by increased populations of native predators such as the Pied Currawong *Strepera graculina* (not applicable to the landfill); and
- Risk of local extinction due to small, isolated populations (not applicable to the landfill).

Recommended recovery actions

- Search for the species in suitable habitat in areas that are proposed for development or management actions;
- Retain dead timber on the ground in open woodland areas;
- Reduce heavy grazing by domestic stock in areas of known or potential habitat, to enable flowering and subsequent seeding of grasses and forbs that this species requires;
- Control weeds in areas of known habitat, especially the exotic, winter-fruiting shrubs such as cotoneasters, Hawthorns, firethorns and privets that support Pied Currawongs;
- Retain and protect woodland, open forest, grassland and mallee habitat from clearing, fragmentation and disturbance. Areas ≥200 ha within woody vegetation are particularly significant, though this species also uses treeless grasslands in the Southern Tablelands;
- Expand and reconnect smaller fragments of habitat by fencing and encouraging natural regeneration or applying revegetation techniques where regeneration fails;
- Ensure remnant populations remain connected or linked to each other and in cases where remnants have lost connective links re-establish links by revegetating sites to act as stepping stones for dispersal; and
- Mark known locations of population on maps or plans.

Koala – Recovery

Threats

- Loss, modification and fragmentation of habitat (direct, though limited, impact due to the landfill access road through TSR);
- Predation by feral and domestic dogs (not applicable to the landfill);
- Intense fires that scorch or kill the tree canopy (not applicable to the landfill); and
- Road-kill (potential indirect effect due to the landfill access road through the TSR).

Recommended recovery actions

- Undertake feral predator control;
- Apply low intensity, mosaic pattern fuel reduction burns in or adjacent to Koala habitat;
- Retain suitable habitat, especially areas dominated by preferred feed-tree species;
- Identify road-kill blackspots and erect warning signs, reduce speed limits or provide safe crossing points to reduce Koala fatalities;
- Protect populations close to urban areas from attacks by domestic dogs; and
- Revegetate with suitable feed tree species and develop habitat corridors between populations.

Narrow-leaved Black Peppermint - Recovery

Threats

- Clearing and fragmentation of habitat for agriculture and grazing (potential, though avoidable, direct but limited impact due to the landfill access road through the TSR);
- Inappropriate fire regimes -There is a risk of population decline with short fire intervals of less than 10 years or long fire free intervals of more than 25 years (potential indirect effect due to the landfill);
- Destruction and disturbance of habitat for roadside management (potential direct effect due to the landfill);
- Grazing by domestic stock (impact ameliorated by stock removal under landfill management);
- Collection of firewood (potential indirect impact due to the landfill access route through the TSR); and
- Collection of seed for horticulture (unlikely indirect impact due to the landfill access route through the TSR).

Recommended recovery actions

- Only buy seed and plants from appropriately licensed dealers and nurseries;
- Support local Landcare groups;
- Manage fire to promote regeneration;
- Practice sustainable grazing in areas of suitable habitat and protect regenerating trees from grazing stock;
- Limit firewood collection in areas of suitable habitat;
- Identify roadside populations and protect during road-works; and
- Protect dry grassy woodland from clearing and fragmentation.

7. Conclusion and Recommendations

The proposed development will result in the loss of 12.7 ha of Stringybark Woodland, 0.6 ha of Box Gum Woodland in the TSR, 6.5 ha of grassland, two small farm dams and 0.5 ha of sedgeland draining into the Gara River.

The potential impact of the proposed development on threatened biodiversity known or likely to occur on the study area were considered in light of a number of key threatening processes. Clearing of native vegetation, removal of dead wood, removal of hollow bearing trees, competition from feral Rabbits and predation by Foxes were considered to be the most relevant to the proposed development. These processes are most likely to impact on the Stringybark Woodland which covers a significant portion of the proposed new landfill footprint area.

The landfill site is located 4 km north of a listed World Heritage Area, Oxley Wild Rivers National Park. No groundwater dependent ecosystems have been identified in the study area, nor in the Oxley Wild Rivers National Park downstream of the proposed new landfill (DNR 2002). The proposed new landfill is not likely to have any impacts on groundwater dependant ecosystems, either in the study area or further downstream in Oxley Wild Rivers National Park.

Five listed threatened species were observed on the study area: Narrow-Leaved Black Peppermint *Eucalyptus nicholii* (TSR), Speckled Warbler *Pyrrholaemus sagittata* (TSR & landfill), Diamond Firetail Finch *Stagonopleura guttata* (TSR & landfill), Eastern Bent-Wing Bat *Miniopterus schreibersii oceanensis* (landfill) and Koala *Phascolarctos cinereus* (TSR and landfill). Two threatened species, Hooded Robin *Melanodryas cucullata cucullata* and Little Lorikeet *Glossopsitta pusilla*, have previously been recorded adjacent to the study area. Three species for which preliminary determination exist and final determinations are pending under the TSC Act were recorded: Little Eagle *Hieraaectus morphnoides* (landfill), Scarlet Robin *Petroica boodang* (TSR & landfill), and Varied Sittella *Daphoenositta chrysoptera* (TSR & landfill). One ROTAP species Bendemeer White Gum (*Eucalyptus elliptica*), a locally significant species though not subject to threatened-species legislation, also occurs in the study area.

The location of the proposed access road through the TSR does not contain core Koala habitat. The location of the proposed landfill operational area does not contain core or potential Koala habitat. In March 2005, one Koala was recorded on the TSR, but was not observed in 2009. Evidence of Koala presence (scats and scratches) was recorded in the landfill footprint area in 2009, but the sight is not primary habitat for Koalas.

One EEC (Box Gum Woodland) occurs in the TSR through which the access road is proposed. A very degraded component of the Box Gum Woodland may be considered to occur in the grassland adjacent to the TSR. Less than 1 ha of the Box Gum Woodland and 3.3 ha of the grassland (degraded Box Gum Woodland) will be removed for the access track.

It is concluded that the loss of habitat due to the proposed development will have a significant impact on local populations of two species of threatened woodland birds (Diamond Firetail Finch and Speckled Warbler) currently listed and three species for which final determination are currently pending (Little Eagle, Scarlet Robin and varied sittella). All five of these species have been recorded on the proposed landfill footprint area. Habitat loss to development on the site will be offset by setting aside adjacent areas of similar vegetation type that are likely to respond to conservation measures which will permanently improve biodiversity values of the offset area (see Offset Management Plan). The impact to all five species will be greatly reduced by provision of these offset areas.

Stringent controls are proposed to be put in place to prevent ground and surface water contamination, limit the spread of weeds and pests, and to protect native biodiversity in the study area. Implementation of the proposed mitigation measures will minimise onsite and offsite impacts on threatened biodiversity and will prevent any significant impacts on the World

Heritage listed Oxley Wild Rivers National Park.

In order to ensure effective implementation of the proposed mitigation measures it is recommended that specific management plans to address key potential impacts be developed as listed below (issues dealt with in other sections of the EA are marked with an *):

- Native Vegetation / Rehabilitation Management Plan
- Compensatory Habitat Offset Management Plan
- Vegetation Clearing Protocol
- Native Fauna Management Plan
- Fire Management Plan
- Weed Management Plan
- Pest Management Plan
- Disease Monitoring Protocol
- Dust Management Plan*
- Noise Abatement Plan*
- Pollution and Litter Management Plan*

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9. Appendices

Appendix A. Assessment of Significance – TSC Act Listed Species

Assessment of Significance – *TSC* Act Listed Species

The Assessment of Significance (also referred to as the '7-part test') as required under Section 5A of the *EP&A* Act, has been applied to determine whether there is likely to be a significant effect on threatened species (endangered and vulnerable) recorded at or likely to occur at the site. Unlisted ROTAP species are not considered in this assessment. A number of species listed under the NSW *TSC* Act are also listed nationally under the *EPBC* Act and are considered in Appendix B.

Under the terms of the *EP&A* and *TSC* Acts, the most critical issues for this assessment are: i) the definition of "local population"; and (ii) the definition of "region". The Acts regard a local population as that inhabiting the study area, unless there is contiguous or proximate occupied habitat. Consideration of a "population" for the purpose of assessing its conservation status requires it to be a recognisable entity, disjunct or genetically distinct. "Region" means a defined bioregion, in this case the New England Tableland Bioregion.

1. Threatened Flora

Endangered Ecological Communities found on the study area:
Box Gum Woodland

Threatened species (Vulnerable) found at the study area:

Eucalyptus nicholii	Narrow-leaved Black Peppermint

Threatened flora with potential habitat occurring on the study area:

Endangered Species:

Diuris pedunculata	Small Snake Orchid

Vulnerable Species:

Dichanthium setosum	Bluegrass
Thesium australe	Austral toadflax

1. **In the case of a threatened species, is the action proposed 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?**

Eucalyptus nicholii **Narrow-leaved Black Peppermint**
Schedule 2 – Vulnerable

This species was recorded on the north western corner of part of the Gara TSR included in the survey area.

Eucalyptus nicholii is a medium-sized tree 15 - 20 m tall with rough, thick, grey-brown bark which extends to the larger branches. Adult leaves are slightly broader than the juvenile leaves, and are a dull grey-green, 6 - 12 cm long and 5 - 10 mm wide and have a strong peppermint smell when crushed.

This species grows in dry grassy woodland, on shallow and infertile soils, mainly on granite. It is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property.

Threats to this species include clearing for agriculture and grazing, inappropriate fire regimes, inappropriate roadside management, grazing by domestic stock, collection of firewood, and collection of seed for horticulture.

The proposed action will involve clearing a small section of the Gara TSR, close to the site where a small population (6 adults and 5 juveniles) of *E. nicholii* was found, for construction of an access road between Waterfall Way and the landfill development site. It is considered unlikely that the proposed development will disrupt the lifecycle of this species such that a viable local population is likely to be placed at risk of extinction. A 30 m buffer around the marked population of *E. nicholii* will be retained during clearing for construction of the proposed access route. Other mitigation measures include erosion and sedimentation control during road construction and ongoing weed control of invasive introduced species, particularly coolatai grass, African lovegrass, serrated tussock, and Chilean needlegrass, will be undertaken.

Diuris pedunculata **Small Snake Orchid**

Schedule 1 – Endangered

This species was not observed on the site nor has it been recorded on the NPWS Wildlife Atlas within 20 km of the site, but it has been recorded in the region.

The Small Snake Orchid is a member of the Yellow Donkey Orchid group and is a delicate native orchid with small golden-yellow flowers on a stem to 20 cm high (flowers from August to November). Leaves are thin, grass-like and pale green in colour. It occurs in a range of vegetation communities from open sclerophyll forest to grassland. This species is often associated with moist and/or swampy areas within these communities. It has been recorded from shale and trap soil, and on fine granite and among boulders.

Shallow drainage lines on the study area have been subject to heavy grazing and are unlikely to provide suitable habitat for this species. It is considered unlikely that the proposed development will disrupt the lifecycle of this species such that a viable local population is likely to be placed at risk of extinction.

Dichanthium setosum **Bluegrass**

Schedule 2 – Vulnerable

This species was not observed on the site but has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

Dichanthium setosum grows in eucalypt woodland and grassland on basalt, black clay and red-brown hardsetting soils.

The proposed action will involve clearing a small section of the Gara TSR, a narrow strip of the derived grassland in the northern half of the study area and regrowth Stringybark Woodland community in the southern part of the study area for construction of an access road and the landfill development area. The TSR provides the only likely habitat for this species since it has not been subject to the level of heavy grazing of the remainder of the study area. The area of TSR to be cleared for road access is likely to be less than 1 ha. It is considered unlikely that the proposed development will disrupt the lifecycle of this species such that a viable local population is likely to be placed at risk of extinction.

Thesium australe **Austral Toadflax**

Schedule 2 – Vulnerable

This species was not observed on the site but has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

Austral toadflax grows in grassland and eucalypt woodland, often in damp sites. This species occurs on a wide range of soils, rainfall regimes and geology. *Thesium australe* is a semi-parasitic herb, and the hosts are most probably *Themeda australis* and *Poa* spp. Other associated species include *Eucalyptus blakelyi*, *E. albens* and *E. viminalis*. It is common to abundant throughout much of the Northern Tablelands and favours areas of dense Kangaroo grass. It appears to be highly sensitive to grazing.

This species is known to occur along St Helena Creek to the east of the study area but is unlikely to occur in the proposed landfill operational area due to the high grazing intensity and relative lack of suitable host grasses. Suitable habitat exists along the TSR adjacent to the study area but no plants were found despite a specifically targeted search.

It is considered unlikely that the proposed development will disrupt the lifecycle of this species such that a viable local population is likely to be placed at risk of extinction.

2. In the case of an endangered population, is the action proposed 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?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any endangered local populations of these species considered.

3. In the case of an endangered ecological community or critically endangered ecological community, is the action proposed:

(i) 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) 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?

i) The endangered ecological community Box Gum Woodland occurs in the TSR and provides suitable habitat for many of the threatened species known or likely to occur in the study area. The proposed development is not 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. The activity will entail clearing of native vegetation for a single access easement through part of this community (0.6 ha in the TSR and 3.3 ha in the cleared grassland).

The area proposed to be cleared through the partially cleared woodland in the Gara TSR is a narrow strip bound by intact Box Gum Woodland (27 ha to the west, 3 ha to the east and 40 ha to the north).

The proposed access route through the cleared grassland (which is included as a degraded component of the Box Gum Woodland due to clearing and grazing) will entail the loss of 3.3 ha of this EEC.

ii) The proposed development is not 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 since the majority of the clearing will entail affect an already partially cleared woodland. Stringent weed control and monitoring will ensure that the composition of the community is not significantly altered.

4. In relation to the habitat of a threatened species, population or ecological community:

(i) to what extent is habitat likely to be removed or modified as a result of the action proposed?

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

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

i) The proposed action will involve clearing of native vegetation for a single access easement through a small section of the Gara TSR containing the Box Gum Woodland EEC . This woodland provides habitat in good condition for the threatened birds and Koala recorded in the TSR. The area to be cleared for the access road is likely to be less than 1 ha.

Approximately 6.5 ha of grassland (3.3 ha of which satisfies the criteria for Box Gum Woodland, Appendix I) will be cleared for the construction of an access road, landfill operational area and two new water storages (leachate and sedimentation ponds). In addition 0.5 ha of sedgeland and 0.01 ha of wetland (2 small farm dams) are proposed to be cleared for the landfill pit.

It is proposed that approximately 12.7 ha of the Stringybark Woodland in the southern section of the study area will be progressively cleared for the landfill pit.

ii) .The part of the Gara TSR included in the survey is 30 ha in area and is adjacent to larger area (over 40 ha) of good condition Box Gum Woodland on the northern side of Waterfall Way, towards Gara River. The clearing of a 200 m x 30 m strip of the TSR for an access route is unlikely to result in fragmentation or isolation from other areas of potential habitat for the threatened species considered.

It is proposed that approximately 12.7 ha of the Stringybark Woodland and 6.5 ha of cleared grassland in the southern section of the study area will be progressively cleared for the development of the landfill site. The proposed mitigation and conservation offset measures will help to increase the connectivity and landscape values of the site by reducing isolation of the Stringybark Woodland, linking it to the Box Gum Woodland to the north of the landfill (see Offset Management Plan).

The proposed clearing of grassland, sedgeland and the wetland (2 small farm dams) is unlikely to result in fragmentation or isolation from other areas that provide potential habitat for the threatened species considered.

iii) The clearing of less than 1 ha of the TSR for an access easement is unlikely to be significant to the long-term survival of the threatened species and communities considered.

The clearing of 12.7 ha of the regrowth Stringybark Woodland is unlikely to be significant to the long-term survival of the threatened species and communities considered.

The proposed clearing of 6.5 ha of grassland and the two small farm dams is unlikely to be significant to the long-term survival of the threatened species and communities considered

5. Is the action proposed likely to have an adverse effect on critical habitat (either directly or indirectly)?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any critical habitat for any species relevant to the study area.

6. Is the action proposed consistent with the objectives or actions of a recovery plan or threat abatement plan?

DECCW has developed a Priority Action Statement (PAS) (DECC 2007) that includes all detailed recovery and threat abatement actions for threatened species in NSW. Priority actions are the specific, practical things that must be done to recover a threatened species, population or ecological community.

Threatened species profiles on the DECCW website lists a number of priority actions that have been identified to help recover the threatened species considered above.

Provided the proposed mitigation measures are implemented, the proposed action is consistent with the recovery actions for the threatened species considered.

7. Does the action proposed constitute or is it part of a key threatening process or is it likely to result in the operation of, or increase the impact of, a key threatening process?

The development will entail clearing of native vegetation in Box Gum Woodland, Stringybark Woodland and cleared grassland for the construction of an access road, the landfill pit and retention ponds. Clearing is a recognised threat to the survival of native species in general and of the threatened species considered. In order to minimise any significant negative impact due to clearing it is proposed to retain, wherever possible, all native vegetation (apart from minimal clearing for the operational requirements of the landfill) and to set aside a compensatory habitat offset. In order to offset the 20.3 ha lost to development, it is proposed to set aside a 61 ha area of Stringybark Woodland and native grassland within the study area to be managed for biodiversity conservation in perpetuity (see Offset Management Plan).

Details of other threatening processes listed under the TSC Act likely to impact threatened species recorded on the site have been assessed in Section 6.8.

2. Threatened Mammals

Threatened mammals recorded at the study area:

Vulnerable Species:

Miniopterus schreibersii oceanensis	Eastern Bent-Wing Bat
Phascolarctos cinereus	Koala

Threatened mammals with potential habitat on the site:

Endangered Species:

No mammals listed as endangered under the TSC Act occur within the New England Tableland Bioregion.

Vulnerable Species:

Squirrel Glider	*Petaurus norfolcencis*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Hoary Wattled Bat	*Chalinolobus nigrogriseus*
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*

1. **In the case of a threatened species, is the action proposed 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?**

Koala *Phascolarctos cinereus*
Schedule 2 – Vulnerable

The Koala was observed on the study area in the Box Gum Woodland on the TSR.

The preferred habitat of the Koala on the tablelands is determined by the presence of the food trees. On the Northern Tablelands 14 eucalypt species are recognised as Koala browse tree species. Four tree species (Yellow Box, Blakely’s Red Gum, Apple-Topped Box, and Narrow-Leaved Black Peppermint) on the study area are described as secondary food trees for the Koala (NPWS 2003). These species occur mainly on the TSR (where the Koala was observed in March 2005). Yellow box also occurs on the southern portion of the study area with New England Stringybark (a supplementary food species) where Koala scats and scratches were recorded in 2009.

The proposed action will involve clearing a section (approximately 13 ha) of the regrowth Stringybark Woodland community and clearing a small section of Box Gum Woodland (less than 1 ha) for an access road. Neither of these areas are considered potential or core Koala habitat under SEPP 44 due to the lack of primary Koala food trees. No signs of Koala were recorded in the *Secondary Habitat (Class A)* (DECC 2008a) of the TSR in 2009. Although habitat scats were found in the Stringybark Woodland at the landfill site, this area is not considered good quality Koala habitat (Section 6.4; DECC 2008a). The action is not likely to have an increased adverse effect on the life cycle of a local population of this species such that a viable local population is likely to be placed at risk of extinction.

Squirrel Glider ***Petaurus norfolcencis***
Schedule 2 – Vulnerable

The Squirrel Glider was not observed on the site, but has been recorded in the NPWS Wildlife Atlas within 20 km of the site.

The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. It inhabits mature or old growth box, box-ironbark woodlands and river Red Gum forest west of the Great Dividing Range and blackbutt-bloodwood forest with heath understorey in coastal areas.

Squirrel gliders utilise remnants of various sizes, including small remnants and even small stands of trees within TSRs or on private land. They often utilise linear remnant vegetation along roadsides or rivers and streams. Squirrel gliders prefer mixed species stands with a shrub or acacia midstorey. They live in family groups of a single adult male one or more adult females and offspring and require abundant tree hollows for refuge and nest sites. Their diet varies seasonally and consists of acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.

This species is more likely to utilise the Box Gum Woodland habitat of the TSR for foraging and nesting than other parts of the study area. The proposed action will involve clearing a small section of Box Gum Woodland for an access road. The proposed access route is in an area that has previously been cleared with a sparse understorey. The action should not have any adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Eastern Bent-Wing Bat ***Miniopterus schreibersii oceanensis***
Schedule 2 – Vulnerable

Ultrasonic bat calls attributed to this species were recorded on the site. Five specimens have been recorded on the NPWS Wildlife Atlas within 20 km of the site.

This species is distributed through eastern and northern Australia. In eastern Australia the species is distributed from Cape York Peninsula to the south-south-east corner of South Australia in a band that extends approximately 300 km inland. This species also occurs in southern Europe, southern Africa, South-east Asia, Japan, New Guinea and the Solomon Islands.

Three distinct forms of *M. schreibersii*, which are treated as subspecies, occur in Australia. *Miniopterus s. orianae* occurs in northern Australia, *M. s. oceanensis* occurs in eastern Australia from Queensland through to central Victoria and *M. s. bassanii* occurs in Western Victoria and eastern South Australia. The eastern subspecies is listed as vulnerable under the TSC Act.

This species is a cave dwelling bat but is also known to roost in man-made structures, such as culverts and mines. Foraging occurs in a range of habitats including rainforest, wet and dry sclerophyll forest open woodland, and grassland. Moths are the main prey item. Foraging is thought to occur above the canopy in wooded areas and closer to the ground in open areas.

The species appears to be tolerant of fragmentation and flexible in its use of habitat. This is not surprising given that this species may travel more than 60 km in a single night and that adult females annually travel long distances to and from maternity caves.

In eastern Australia this species forms discrete populations centred on maternity caves that are used annually for birth and development of young between October and March. Populations of up to 100,000 females may congregate at maternity caves each year. Each population then disperses to other caves within a territorial range of approximately 300 km from the maternity cave.

No caves were detected on the study area and it is considered unlikely that this species roosts in the area. There are likely to be caves and mining adits that form suitable roost sites in the gorge country 6 km south and 8 km east of the site. Potential foraging habitat for this species is considered to occur within and above the Box Gum Woodland and Stringybark Woodland. The grassland and sedgeland are considered to provide low quality foraging habitat for this species.

The proposed development will involve clearing a section of the Stringybark Woodland community and a small section of Box Gum Woodland for an access road. Given that suitable roosts do not exist on the study site and that there are large areas of similar woodland habitats in the region, the action is not anticipated to have an adverse effect on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Eastern False Pipistrelle *Falsistrellus tasmaniensis*
Schedule 2 – Vulnerable

This species was not observed on the site. It has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

The false pipistrelle is a large robust bat whose distribution area includes the coast and tablelands from south eastern Queensland to Victoria and Tasmania. It inhabits sclerophyll forests from the Great Dividing Range to the coast, but prefers wet habitats where trees are higher than 20 m. They generally roost in hollow trees in colonies of 3 – 36 and are also found in old wooden buildings. This species is known to have large foraging ranges >12 km and usually forage within or just below the tree canopy. A single young is born in December abd lactation continues through to February.

The proposed action will involve clearing a section (approximately 12.7 ha) of the regrowth Stringybark Woodland community and a small section (0.6 ha) of Box Gum Woodland for an access road. The Stringybark Woodland habitat is not generally utilised by this species, and the regrown trees are generally too young to support suitable hollows for roosting sites. Therefore, the action will not have any adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Hoary Wattled Bat *Chalinolobus nigrogriseus*
Schedule 2 – Vulnerable

This species was not observed on the site. It has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

In northeast NSW, the distribution of the hoary wattled bat reaches the lower Clarence and Richmond River areas, extending from near Murwillumbah in the north, south to between Grafton and Coffs Harbour. It occurs in dry open eucalypt forests, favouring forests dominated by spotted Gum, boxes and ironbarks, and heathy coastal forests where red bloodwood and scribbly gum are common. It flies fast below the canopy level, thus forests with naturally sparse understorey layers may provide the best habitat.

The Box Gum Woodland on the TSR may provide potential roosting and foraging habitat for this bat. However, since this species has mostly been recorded in coastal open forests, it is highly unlikely that it would be found in the vicinity of the landfill site. Clearance of woodland for the landfill is unlikely to have any significant impact on any potentially occurring local populations of this species.

Yellow-Bellied Sheathtail Bat ***Saccolaimus flaviventris***
Schedule 2 – Vulnerable

This species was not observed on the site nor has it been recorded on the NPWS Wildlife Atlas within 20 km of the site, but it has been recorded in the New England Tablelands Bioregion.

It has a wide distribution, but is rarely recorded because of its high and rapid flying tactics. It occurs in most wooded habitats and northern floodplains and bimble box–pine lands are known to be preferred habitat. During the day it roosts in large tree hollows.

The proposed action will involve clearing a section (~13 ha) of the regrowth Stringybark Woodland community and clearing a small area of Box Gum Woodland for an access easement. The Stringybark Woodland habitat is not generally utilised by this species, and the regrown trees are mostly too young to support suitable hollows for roosting sites. This species could inhabit the Box Gum Woodland in the TSR, but was not recorded on the site. It is unlikely that the proposed access route through the TSR will have an adverse effect on the life cycle this species such that a viable local population is likely to be placed at risk of extinction.

2. In the case of an endangered population, is the action proposed 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?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any endangered local populations of these species considered.

3. In the case of an endangered ecological community or critically endangered ecological community, is the action proposed:
   (i) 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) 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?

i) The Box Gum Woodland EEC occurs on the study area and provides suitable habitat for many of the threatened species known or likely to occur in the study area. The proposed development is not 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 since the activity will entail minimal clearing (less than 1 ha) of native vegetation for a single access easement through part of this community. The proposed access route through the cleared grassland (degraded component of the Box Gum Woodland) will entail the loss of 3.3 ha of this EEC.

ii) The proposed development is not 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 since the majority of the clearing will entail clearing of already degraded woodland. The total Box Gum Woodland area to be cleared includes 3.3 ha of degraded woodland in the cleared grassland and 0.6 ha of partially cleared woodland in the TSR.

4. In relation to the habitat of a threatened species, population or ecological community:
   (i) to what extent is habitat likely to be removed or modified as a result of the action proposed?
   (ii) is an area of habitat likely to become fragmented or isolated from other areas of habitat as a result of the proposed action? and

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

i) The proposed action will involve clearing of native vegetation for a single access easement through a small section of the Gara TSR containing the Box Gum Woodland EEC. This woodland may provide potential habitat for the threatened mammals considered. The area of the TSR to be cleared for the access road is likely to be 0.6 ha. Approximately 12.7 ha of the Stringybark Woodland in the southern section of the study area may be progressively cleared for the development of the landfill site. However, this community is not likely to provide suitable roosting habitat for bats due to the lack of tree hollows and does not support suitable Koala feed trees.

ii) The part of the Gara TSR included in the survey is 30 ha and is adjacent to larger area (>40 ha) of good condition Box Gum Woodland on the northern side of Waterfall Way towards Gara River. The clearing of a 200 m x 30 m strip of the TSR for an access easement is unlikely to result in fragmentation or isolation from other areas potential habitat for the threatened species considered.

iii) The clearing of 0.6 ha of the TSR for an access easement is unlikely to be significant to the long-term survival of the threatened mammals considered. No evidence of Koala usage of the TSR is currently evident (2009).

The clearing of 12.7 ha of the regrowth Stringybark Woodland is unlikely to be significant to the long-term survival of the threatened mammals considered.

The proposed clearing of 6.5 ha of grassland and 0.5 ha of sedgeland is unlikely to be significant to the long-term survival of the threatened mammals considered.

5. Is the action proposed likely to have an adverse effect on critical habitat (either directly or indirectly)?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any critical habitat for any species relevant to the subject land.

6. Is the action proposed consistent with the objectives or actions of a recovery plan or threat abatement plan?

DECCW has developed a Priority Action Statement (PAS) (DECC 2007) that includes all detailed recovery and threat abatement actions for threatened species in NSW. Priority actions are the specific, practical things that must be done to recover a threatened species, population or ecological community.

Threatened species profiles on the DECCW website lists a number of priority actions that have been identified to help recover the threatened species considered above.

Provided the proposed mitigation measures are implemented, the proposed action is consistent with the recovery actions for the threatened species considered.

7. Does the action proposed constitute or is it part of a key threatening process or is it likely to result in the operation of, or increase the impact of, a key threatening process?

Details of threatening processes listed under the TSC Act likely to impact threatened species recorded on the site have been assessed in Section 6.8.

Threatened Birds

Threatened birds recorded at the study area:

Vulnerable Species:

Stagonopleura guttata	Diamond Firetail Finch
Pyrrholaemus sagittata	Speckled Warbler

Potentially threatened bird species recorded at the study area:

Vulnerable Species (Preliminary Determination (PD)):

Hieraaetus morphnoides	Little Eagle
Petroica boodang	Scarlet Robin
Daphoenositta chrysoptera	Varied Sittella

Threatened birds with habitat occurring on the site:

Endangered Species:

Xanthomyza phrygia	Regent Honeyeater

Vulnerable Species:

Ninox connivens	Barking Owl
Melithreptus gularis gularis	Black-chinned Honeyeater
Climacteris picumnus victoriae	Brown Treecreeper
Melanodryas cucullata cucullata	Hooded Robin
Glossopsitta pusilla	Little Lorikeet
Lophoictinia isura	Square tailed Kite
Petaurus norfolcencis	Squirrel Glider

Potentially Threatened fauna with habitat occurring on the site:

Vulnerable Species (Preliminary Determination (PD)):

Petroica phoenicea	Flame Robin
Artamus superciliosus	White-browed Woodswallow

1. **In the case of a threatened species, is the action proposed 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?**

Barking Owl ***Ninox connivens***
Schedule 2 – Vulnerable

This species was not observed on the site but has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

The barking owl is found in northern and eastern Australia and extreme south-western Western Australia. On the Northern Tablelands, it prefers large areas of productive woodland (e.g. Box Gum or riparian) that support populations of sugar gliders, its main prey (Debus 2001; Debus *et al.* 2005). The barking owl requires large trees hollows for nesting and roosts in tall, dense understorey trees. The young, small, isolated and degraded patch of Stringybark Woodland on the subject site, lacking understorey and hollows and having low densities of arboreal mammals, is considered unlikely to constitute important habitat or to be occupied or visited by barking owls.

Large mature eucalypts in the TSR may provide suitable habitat for the Barking Owl in the form of tree hollows.

The proposed action will involve clearing a section (approximately 12.7 ha) of the regrowth Stringybark Woodland community and clearing a small section of Box Gum Woodland for an access road. The Stringybark Woodland habitat is unlikely to be utilised by this species, as the undergrowth is too sparse and low for roosting sites and the regrown trees are generally too young to support suitable hollows for nesting sites. Therefore the action is unlikely to have any adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Black-Chinned Honeyeater *Melithreptus gularis gularis*
Schedule 2 – Vulnerable

This species was not observed on the site but has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

The subspecies is widespread, from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range.

Black-chinned Honeyeaters occupy mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts. It also inhabits open forests of smooth-barked gums, Stringybarks, ironbarks and tea-trees.

This species is usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic with large home ranges of at least 5 ha. It breeds solitarily or co-operatively, with up to five or six adults, from June to December. The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage.

The proposed action will involve clearing a small section of Box Gum Woodland for an access road and approximately 12.7 ha of the regrowth Stringybark Woodland community. These areas may contain potential habitat for nesting by this species, although it is unlikely to occur east of Armidale. Given the likely absence of the species from the Subject Site, the action is unlikely to have an adverse impact on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Brown Treecreeper *Climacteris picumnus victoriae*
Schedule 2 – Vulnerable

This species was not observed on the site but has been recorded in the NPWS Wildlife Atlas within 20 km of the site.

The Brown Treecreeper is a medium-sized insectivorous bird that occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows and fallen logs within permanent territories, breeding in pairs or communally in small groups. Birds forage for ants, beetles and larvae on tree trunks, on the ground amongst leaf litter and on fallen logs. The eggs are laid in a tree hollow, sparsely lined with leaves, grass, Rabbit or kangaroo droppings, or charcoal. Flight is purposeful, with rapid beats on ‘windowed’ wings interspersed with undulating glides.

The eastern subspecies of the Brown Treecreeper, *Climacteris picumnus victoriae*, is distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys.

Brown Treecreepers are threatened by vegetation clearance, including removal of dead timber, and woodland habitat fragmentation. This species appears unable to maintain viable populations in remnants less than 200 ha. In addition, Brown Treecreepers are likely to be threatened by such factors as increased competition with aggressive honeyeater species and increased levels of nest predation that are a consequence of fragmentation of habitat (NPWS 2001a).

Standing dead trees and logs in the Box Gum Woodland on the TSR may provide suitable nesting and foraging habitat for Brown Treecreepers. The proposed action will involve clearing a small section of Box Gum Woodland for an access road and 12.7 ha of the regrowth Stringybark Woodland community. The Stringybark Woodland habitat is not likely to be utilised for nesting by this species since the regrown trees are generally too young to support suitable hollows. Thus, the action will not have adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Diamond Firetail Finch *Stagonopleura guttata*
Schedule 2 – Vulnerable

The Diamond Firetail Finch was observed on the site in both the TSR and the landfill site.

The Diamond Firetail Finch is distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range. On the New England Tableland, declines in populations are apparent and the species has become extinct within Imbota Nature Reserve and surrounds.

The Diamond Firetail is a brightly coloured finch that occupies eucalypt woodlands, forests and mallee where there is a grassy understorey. Diamond Firetails build bottle-shaped nests in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects.

The Diamond Firetail is threatened by clearance and fragmentation of habitat. Isolation and reductions in remnant area inhibit dispersal and increase their vulnerability to local extinction. Diamond Firetail Finch populations appear unable to persist in areas which lack remnants of native vegetation larger than 200 ha. Habitat degradation, particularly overgrazing of the grass understorey, threatens the granivorous Diamond Firetail. In addition, an increased abundance of predators such as Pied Currawongs and Australian Ravens may increase nest predation in fragmented woodland remnants.

Both the Box Gum Woodland on the TSR and the Stringybark Woodland provide suitable foraging habitat and may provide suitable nesting habitat for Diamond Firetail Finch. The proposed action will involve clearing of a small section of Box Gum Woodland for an access road and progressive clearing of 12.7 ha of the regrowth Stringybark Woodland community. Given that the species is widespread locally, including in reserves (Debus *et al.* 2006), the action is unlikely to have an adverse effect on the life cycle such that a viable local population is likely to be placed at risk of extinction. However, the clearing of the Stringybark Woodland will significantly impact 1-2 pairs of finches and considerably reduce the genetic diversity of the species in the area (Ford et al. 2009). It is strongly recommended that suitable habitat be increased in the immediate area by the provision of habitat offsets. This will potentially provide habitat for the existing pairs that will be impacted by the development to disperse without encroaching on the territories of other pairs or individuals.

Flame Robin *Petroica phoenicea*
Schedule 2 – Vulnerable (PD)

The Flame Robin was not observed on the site but has suitable habitat in the grassland and open Box Gum Woodland in the study area.

The Flame Robin is a small songbird, grey on the upperside, with white flashes in the wings and tail and a small white spot on the forehead. The orange-red on the underside extends from the chin to the belly. The female is browner, without a red breast. It breeds in moist grassy forests and alpine woodlands in highland south-eastern Australia, migrating to open woodland and grassland at lower altitudes in winter. This species is likely to occur on the Subject Site, and is known from other local woodland in the vicinity.

Flame Robins forage on insects, mostly by pouncing to the ground from a low perch. They build an open, fibrous nest in forks and crevices of trees and stumps, and breed in spring (Higgins and Peter 2002).

As the grassland and open Box Gum Woodland in the study area will be minimally affected by the proposal in relation to the its total area on the site, it is considered unlikely that the proposed action will disrupt the lifecycle of this species such that any potentially viable local population would be placed at risk of extinction.

Hooded Robin *Melanodryas cucullata cucullata*
Schedule 2 – Vulnerable

The Hooded Robin was not observed on the site but has previously been recorded adjacent to the site in the portion of the Gara TSR, but have not been recorded in the area since 2003 (S. Debus, pers. comm.).

The south-eastern form of the Hooded Robin is distributed throughout south-eastern Australia, from Central Queensland, to Spencer Gulf, South Australia. This form of the Hooded Robin occurs throughout NSW except for the north-west of the state where it inter-grades with the smaller northern form of the Hooded Robin *M. cucullata picata*. This species occupies a wide range of Eucalypt woodlands, Acacia shrublands and open forests. In temperate woodlands, the species favours open areas adjoining large woodland lots, with areas of dead timber and sparse shrub cover.

Hooded Robins live in small family groups of pairs or trios, and build cup-shaped nests. Home ranges are relatively large and averaged 18 ha for birds from the New England Tableland. The species feeds on the ground by pouncing on insects, and forages in areas with a mix of bare ground, ground cover and litter.

The Hooded Robin is threatened by clearance and fragmentation of habitat including removal of dead timber. The species appears unable to survive in remnants smaller than 100-200 ha. Isolation of populations in small remnants increases vulnerability to local extinction. Habitat degradation by stock grazing and weed invasion may reduce food resources for this species. The breeding success of Hooded Robins may be reduced by increased populations of nest predators such as Pied Currawongs and Australian Ravens (NPWS 2001c).

The Box Gum Woodland on the TSR may provide suitable nesting and foraging habitat for Hooded Robins, but they are known to have recently disappeared from Gara TSR (Ford et al. 2009). The proposed action will involve clearing of a small section of Box Gum Woodland for an access road and progressive clearing of 12.7 ha of the regrowth Stringybark Woodland community. As Hooded Robins no longer occur in the local area, the action is unlikely to have an adverse effect on the life cycle of any potentially occurring local population of this species such that a viable local population would be likely to be placed at risk of extinction.

Little Eagle *Hieraaetus morphnoides*
Schedule 2 – Vulnerable (PD)

The Little Eagle is a small chunky eagle, either brown on the upperside and white on the underside, or sometimes mostly brown, with a rusty, black-marked head, pale shoulder band, and feathered legs. It soars and glides on flat wings. It occurs throughout the drier parts of Australia, from open forest to open woodland. This species was observed to occur and breed on the study area and is known from other local woodland in the vicinity.

Little Eagles hunt, mostly in flight, for living prey (especially Rabbits) taken mainly on the ground, with a foraging range of more than 1,500 ha per pair. They sometimes eat carrion, such as road-killed Rabbits. Pairs breed in a stick nest in a living woodland tree, in a patch of woodland, and the long nesting cycle lasts from late winter to early summer (Debus et al 2007; Debus and Ley 2009).

Both the Box Gum Woodland on the TSR and the Stringybark Woodland provide suitable foraging habitat and nesting habitat for the Little Eagle. The proposed action will involve clearing of a small section of Box Gum Woodland for an access road and progressive clearing of 12.7 ha of the regrowth Stringybark Woodland community, which contains the eagles' nest site. Pairs have been known to shift their nest site up to 1.5 km (Debus *et al*. 2007), and there is suitable nesting habitat in the TSR and in the offset zone adjoining the landfill site. Given that there are an additional eight breeding pairs within 10 km of Armidale (Debus & Ley 2009), the action is unlikely to disrupt the lifecycle of this species such that any potentially viable local population would be placed at risk of extinction.

Little Lorikeet *Glossopsitta pusilla*
Schedule 2 – Vulnerable

The Little Lorikeet is a small, short-tailed green parrot with a red face, occurring in open forest and woodland in eastern and south-eastern Australia. This species is likely to forage and breed on the Subject Site, and is known from other local woodland in the vicinity.

Little Lorikeets forage in pairs or flocks for nectar from eucalypt blossom, especially box and ironbark species. Although flocks are mobile, adult breeding pairs occupy traditional nest sites throughout much of the year, near their food sources, and return regularly to defend and maintain them in the non-breeding season. The Lorikeets breed, sometimes semi-colonially, in small cavities typically in living smooth-barked gums, which they maintain at a precise entrance diameter by chewing the living bark. Two broods of young may be raised per year, from late autumn to late spring or early summer, if their key food trees (White Box *Eucalyptus albens* and Yellow Box *E. melliodora* in the New England region) are flowering profusely (Courtney and Debus 2006).

The Little Lorikeet is known from the study area and is likely to use the TSR for foraging or nesting. Yellow Box is an important food for this lorikeet. Yellow Box is a co-dominant species in the TSR with Blakely's Red Gum, which is a preferred nest tree.

Great caution must be exercised prior to the removal of any trees on the Site. This species' nests can be hard to identify and **any tree containing a bird nest must be checked for eggs or young by a knowledgeable ecologist or zoologist prior to removal**. As most of the Box Gum Woodland in the TSR will not be affected by the proposal, it is considered unlikely that the proposed action will disrupt the lifecycle of this species such that any potentially viable local population would be placed at risk of extinction. However, **care and due diligence must be undertaken during tree removal in the TSR and of Yellow Box trees in the landfill site**.

Regent Honeyeater *Xanthomyza Phrygia*
Schedule 1 – Endangered

This species was not observed on the site but has been recorded on the NPWS Wildlife Atlas within 20 km of the site.

The Regent Honeyeater is known to occur in the Armidale area and along the western slopes north to Barraba. It is a nomad, often occurring in flocks, which follow the seasonal flowering of eucalypts particularly favouring those on the wettest, most fertile soils, such as along creek flats and broad river valleys. They spend much of their time feeding on the nectar from eucalypts such as the mugga ironbark, narrow-leaf ironbark, white box, Yellow Box and Blakely’s Red Gum trees on which they are reliant. Its diet includes both insects and nectar. It is a somewhat pugnacious bird, fighting its own kind as well as other species. It nests in an upright fork of a tree several metres from the ground. The breeding season occurs between July and November.

The distribution of the regent honeyeater is in South-eastern Australia from Adelaide, South Australia, to Rockhampton, Queensland. Though this species is widely dispersed, the range of this once abundant honeyeater has contracted dramatically (UBBS 1996). The species distribution is now extremely patchy, with the population having declined to less than 1500 individuals (NPWS 1997). There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungle NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley and Capertee Valley (NPWS 1997a).

A review of the recovery plan for the Regent Honeyeater, Menkhorst *et al* 1999, indicates that this site does not constitute priority habitat and the recommended measures to reduce negative impacts on Box Gum Woodland (below) will also reduce negative impacts the Regent Honeyeater.

The proposed action will involve clearing a section (approximately 13 ha) of the regrowth Stringybark Woodland community and clearing a small section of Box Gum Woodland for an access road. The Stringybark Woodland habitat is not generally utilised by this species, and the regrown trees are too young to support a large flowering resource. Therefore, the action will not have an adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Scarlet Robin *Petroica boodang*
Schedule 2 – Vulnerable (PD)

The Scarlet Robin was recorded in both the TSR and the landfill site and at other local woodland near the site.

The Scarlet Robin is a small songbird, black on the head and upperside, with white flashes in the wings and tail and a large white spot on the forehead. The red on the breast extends from the black chin to the white belly. The female is browner, with a dull red breast. It occurs in the drier open, grassy forests and temperate woodlands in south-eastern and south-western Australia.

Scarlet Robins forage on insects, mostly by pouncing to the ground from a low perch. They build an open, fibrous nest, typically in a fork of a mature living tree and sometimes on a dead branch, and breed in spring (Debus 2006).

Both the Box Gum Woodland on the TSR and the Stringybark Woodland provide suitable foraging habitat and may provide suitable nesting habitat for the Scarlet Robin. The proposed action will involve clearing of a small section of Box Gum Woodland for an access road and progressive clearing of 12.7 ha of the regrowth Stringybark Woodland community. Given that only one territory is affected, and the species is widespread locally, including in reserves (Debus 2006), the action is unlikely to have an adverse effect on the life cycle of a local population of this species such that a viable local population is likely to be placed at risk of extinction. However, the genetic diversity of the species in the local area will be reduced should these pair(s) perish due to clearing. It is strongly recommended that suitable habitat be increased in the immediate area by the provision of habitat offsets. This will potentially provide habitat for the existing pairs that will be impacted by the development to disperse without encroaching on the territories of other pairs or individuals.

Speckled Warbler *Pyrrholaemus sagittata*
Schedule 2 – Vulnerable

The Speckled Warbler was observed on the site in both the TSR and at the landfill site.

Speckled Warblers inhabit woodlands with a grassy understorey, often on ridges or gullies. The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Ford *et al*. 1986). Populations occur in low densities about 2 birds per hectare (Gardner *et al* 2004). Home ranges vary from 6-12 hectares.

The Speckled Warbler is distributed from south-eastern Queensland, through central and eastern NSW to Victoria. In NSW, Speckled Warblers occupy eucalypt and cypress woodlands on the slopes west of the Great Dividing Range, with an extension of range into the cypress woodlands of the northern Riverina. Populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys.

The preferred foraging habitat of Speckled Warbler is areas with a combination of open grassy patches, leaf litter and shrub-cover. This habitat is susceptible to degradation by stock and weed invasion. Nesting on the ground also makes them vulnerable to predation from exotic mammalian predators such as Foxes and Cats. The Speckled Warbler is threatened by clearance and fragmentation of habitat including removal of dead timber. Barrett et al. (1994) found that the species decreased in abundance as woodland area decreased, and it appears to be extinct in districts where no fragments larger than 100 ha remain (NPWS 2001b).

The Box Gum Woodland on the TSR and the Stringybark Woodland provides suitable foraging habitat and may provide suitable nesting habitat for the Speckled Warbler. The proposed action will involve clearing a small section (0.6 ha) of Box Gum Woodland for an access road and 12.7 ha of the regrowth Stringybark Woodland community. The clearing of the Stringybark Woodland could significantly impact several pairs of finches and considerably reduce the genetic diversity of the species in the area (Ford et al. 2009) such that viable local population is significantly impacted. It is strongly recommended that suitable habitat be increased in the immediate area by the provision of habitat offsets. This will potentially provide habitat for the existing pairs that will be impacted by the development to disperse without encroaching on the territories of other pairs or individuals.

Square Tailed Kite *Lophoictinia isura*
Schedule 2 – Vulnerable

The Square-tailed Kite was not observed on the site, but has been recorded in the NPWS Wildlife Atlas within 20 km of the site.

The Square-tailed Kite is sparsely scattered throughout the open forests and dry woodlands of the western slopes of the Great Dividing Range. It prefers vegetation along major rivers and belts of trees in urban or semi-urban areas for hunting and nests in large trees along water courses. The Square-tailed Kite preys on bird nests (mostly on nestling and fledglings) in woodlands and open forests. The region may be part of a pair's territory, which is usually <100 km^2. Raptors benefit from abundance of prey, in this case fledgling birds (although small mammals, reptiles and frogs are also eaten). Nesting sites are usually within 100 m of a watercourse. The protection of all watercourses as corridors would benefit this species (Ayers *et al* 1996).

This species is more likely to utilise the Box Gum Woodland habitat of the TSR for foraging and nesting than other parts of the study area. The proposed action will involve clearing 12.7 ha of the regrowth Stringybark Woodland community and clearing a small section of Box Gum Woodland for an access road. The action will not have any adverse effects on the life cycle of any potential local populations of this species such that a viable local population is likely to be placed at risk of extinction.

Varied Sittella *Dapoenositta chrysoptera*
Schedule 2 – Vulnerable (PD)

The Varied Sittella was recorded in the TSR and in the area of the landfill footprint and is known from other local woodland in the vicinity.

The Sittella is a small songbird, streaky grey-brown on the upperside, white with dark streaks on the underside, and having a prominent orange band through the wings in flight. The thorn-like beak is slightly upturned, and the feet are yellow. It occurs in a variety of open forests, woodlands and scrub throughout much of Australia, and its head colour varies from white on the eastern subtropical coast, to grey-brown over most of NSW, to a black cap (and a whiter underside) in the far inland and west.

Sittellas forage socially on insects, by clambering among tree branches and probing bark and dead wood. They build an open, fibrous nest in upright dead forks of trees, and breed in spring (Higgins & Peter 2002).

Both the Box Gum Woodland on the TSR and the Stringybark Woodland provide suitable foraging habitat and may provide suitable nesting habitat for the Scarlet Robin. The proposed action will involve clearing of a small section of Box Gum Woodland for an access road and progressive clearing of 12.7 ha of the regrowth Stringybark Woodland community. Given that only one territory is affected, and the species is widespread locally, including in reserves (Debus *et al.* 2006), the action is unlikely to have an adverse effect on the life cycle of a local population of this species such that a viable local population is likely to be placed at risk of extinction. However, the genetic diversity of the species in the local area will be reduced should these pair(s) perish due to clearing. It is strongly recommended that suitable habitat be increased in the immediate area by the provision of habitat offsets. This will potentially provide habitat for the existing pair(s) that will be impacted by the development to disperse without encroaching on the territories of other pairs or individuals.

White-Browed Woodswallow *Artamus superciliosus*
Schedule 2 – Vulnerable (PD)

The White-browed Woodswallow was not recorded in the study area.

The White-browed Woodswallow is a small songbird, blue-grey on the upperside, with white eyebrows and tail tip, chestnut underside, and triangular pointed wings in flight. The female is duller. It occurs widely in the drier open forests and woodlands of central and inland eastern

Australia, though erratically, in only some years, on the eastern edge of its range. This species is likely to occur in the study area, and is known from other local woodland in the vicinity.

Woodswallows forage in flocks aerially on insects, sometimes by pouncing to the ground, and also take nectar from eucalypt blossom. Pairs build an open nest of twigs, in forks and crevices of trees and stumps, and breed in spring (Higgins et al 2006).

As only part of the woodland cover in the study area will be affected by the proposal, with offset areas preserved, and the species migrates to the region only in some years, it is considered unlikely that the proposed action will disrupt the lifecycle of this species such that any potentially viable local population would be placed at risk of extinction.

2. In the case of an endangered population, is the life-cycle of a species that constitutes the endangered population likely to be disrupted such that a viable local population is likely to be significantly compromised?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any endangered local populations of the species considered that are relevant to the study area.

3. In the case of an endangered ecological community or critically endangered ecological community, is the action proposed:
   (i) 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) 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?

i) The Box Gum Woodland EEC occurs on the study area and provides suitable habitat for many of the threatened species known or likely to occur in the study area. The proposed development is not 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 since the activity will entail minimal clearing (0.6 ha) of native vegetation for a single access easement through part of this community. The proposed access route through the cleared grassland (a degraded component of the Box Gum Woodland) will entail the loss of 3.3 ha of this EEC.

ii) The proposed development is not 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 since the majority of the clearing will entail clearing of already degraded woodland. The total Box Gum Woodland area to be cleared includes 3.3 ha of degraded woodland in the cleared grassland and 0.6 ha of partially cleared woodland in the TSR.

4. In relation to the habitat of a threatened species, population or ecological community:
   (i) to what extent is habitat likely to be removed or modified as a result of the action proposed?
   (ii) is an area of habitat likely to become fragmented or isolated from other areas of habitat as a result of the proposed action? and
   (iii) how important is the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality?

i) Two threatened and three provisionally listed (preliminary determination) bird species were observed in the study area. Four of these species were recorded in both the TSR and the Stringybark Woodland, with a Little Eagle nest present within the landfill footprint.

The proposed action will involve clearing of native vegetation for a single access easement through a small section of the Gara TSR containing EEC Box Gum Woodland. This woodland provides habitat in good condition for the threatened birds. The area to be cleared for the access road through the TSR is likely to be 0.6 ha.

Approximately 6.5 ha of cleared grassland (including 3.3 ha which satisfies the criteria for degraded Box Gum Woodland Appendix I) will be cleared for the construction of an access road, landfill operational area and two new water storages (leachate and sedimentation ponds).

Approximately 0.5 ha of sedgeland and 0.01 ha of wetland (2 small farm dams) are proposed to be cleared for the landfill pit.

It is proposed that approximately 12.7 ha of the Stringybark Woodland in the southern section of the study area will be progressively cleared for the landfill pit.

ii) The part of the Gara TSR included in the survey is 30 ha in area and is adjacent to larger area (over 40 ha) of good condition Box Gum Woodland on the northern side of Waterfall Way, towards Gara River. The clearing of a 200 m x 30 m strip of the TSR for an access route is unlikely to result in fragmentation or isolation from other areas of potential habitat for the threatened species considered.

It is proposed that approximately 12.7 ha of the Stringybark Woodland and 6.5 ha of cleared grassland in the southern section of the study area will be progressively cleared for the development of the landfill site. The proposed mitigation and conservation offset measures (Section 4) will help to increase the connectivity and landscape values (Section5.1.7) of the site by reducing isolation of the Stringybark Woodland by linking it to the Box Gum Woodland to the north of the landfill.

The proposed clearing of grassland, sedgeland and the wetland (2 small farm dams) are unlikely to result in fragmentation or isolation from other areas that provide potential habitat for the threatened species considered.

iii) The intact Box Gum Woodland on the TSR provides habitat in good condition for the threatened birds recorded on the site. The area of partially cleared woodland to be cleared for the access road is likely to be 0.6 ha and will not significantly impact the long-term survival of the Little Lorikeet, Speckled Warbler, Scarlet Robin, Varied Sittella, or Diamond Firetail.

The Stringybark Woodland in the southern section of the study area will be progressively cleared for the development of the landfill site. Proposed clearing and the ongoing disturbance from the operation of the landfill pit is likely to impact on the long-term survival of individual pairs or groups of the Speckled Warbler, Diamond Firetail, Scarlet Robin, Varied Sittella and Little Eagle utilizing the Stringybark Woodland.

The proposed clearing of grassland and the two small farm dams is unlikely to be significant to the long-term survival of the threatened species considered.

5. Is the action proposed likely to have an adverse effect on critical habitat (either directly or indirectly)?

Not applicable, as the Director-General of the National Parks and Wildlife Service has not declared any critical habitat for the threatened species considered.

6. Is the action proposed consistent with the objectives or actions of a recovery plan or threat abatement plan?

DECCW has developed a Priority Action Statement (PAS) (DECC 2007) that includes all detailed recovery and threat abatement actions for threatened species in NSW. Priority actions are the specific, practical things that must be done to recover a threatened species, population or ecological community.

Threatened species profiles on the DECCW website lists a number of priority actions that have been identified to help recover the threatened species considered above.

Provided the proposed mitigation measures are implemented, the proposed action is consistent with the recovery actions for the threatened species considered.

7. Does the action proposed constitute or is it part of a key threatening process or is it likely to result in the operation of, or increase the impact of, a key threatening process?

Details of threatening processes listed under the TSC Act likely to impact threatened species recorded on the site have been assessed in Section 6.8.

Appendix B. Assessment of EPBC Matters of National Environmental Significance

The assessment of the impact of the proposed development on threatened species, populations and ecological communities, World Heritage values, and migratory species listed under the EPBC Act is presented below. It follows the Significant Impact Guidelines set out in EPBC Act Policy Statement 1.1 (DEH 2006b).

1. Impacts on Critically endangered and endangered species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate 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 by becoming established in the endangered or critically endangered species habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

No species listed as critically endangered or endangered were recorded on the study area.

An assessment of the likelihood of occurrence on the site of species listed in the EPBC Act (Table 5) indicated that one endangered plant species and one endangered bird species may have potential habitat occurring on the site:

- Small Snake Orchid, *Diuris pedunculata* - Potential habitat for the *D. pedunculata* occurs on the study area along the shallow drainage lines and other moist areas.
- Regent Honeyeater, *Xanthomyza Phrygia* - Potential habitat for the Regent Honeyeater occurs in the Box Gum Woodland on the study area.

Potential Impacts on *Diuris pedunculata,* Small Snake Orchid

- The proposed development is not likely to lead to long-term decrease in the size of a potential population of this species since the history of heavy grazing would greatly reduce the chances of this species occurring on the site.
- The proposed development is not likely to reduce the area of occupancy of *D. pedunculata* since it has not been recorded on the study area.
- The proposed development is not likely to fragment an existing population into two or more populations since *D. pedunculata* has not been recorded on the study area.
- The proposed development is not likely to adversely affect habitat critical to the survival of *D. pedunculata* since no critical habitat has been identified for this species in the register maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of a population of *D. pedunculata* since it has not been recorded on the study area and the proposed development will entail minimal disturbance of potential habitat for this species.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *D. pedunculata* is likely to decline since it has not been recorded on the study area and the proposed development will entail minimal disturbance of potential habitat for this species.
- The proposed development is not likely to result in invasive species that are harmful to the endangered species by becoming established in the endangered species’ habitat since it is proposed to implement appropriate weed management which will target invasive

species that are harmful to *D. pedunculata* and/or potential habitat for this species (along shallow drainage lines and other moist areas on the site).

- The proposed development is not likely to introduce disease that may cause the species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- The proposed development is not likely to interfere with the recovery of *D. pedunculata* since it has not been recorded on the study area and the proposed development will entail minimal disturbance of potential habitat for this species. No recovery plans been prepared for this species.

Potential Impacts on *Xanthomyza phrygia,* Regent Honeyeater

- The proposed development is not likely to lead to long-term decrease in the size of potential population of the Regent Honeyeater since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to reduce the area of occupancy of a population of this species since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to fragment an existing population into two or more populations since Regent Honeyeaters have not been recorded in the study area.
- The proposed development is not likely to adversely affect habitat critical to the survival of this species since no critical habitat has been identified for the Regent Honeyeater in the register for critical habitat maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of a population of this species since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that this species is likely to decline since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed clearing for access through the TSR is not likely to result in invasive species that are harmful to the endangered species by becoming established in the endangered species' habitat since weed management on the landfill site will include targeted monitoring and control of invasive species that may impact on potential habitat for this species.
- The proposed development is not likely to introduce disease that may cause the species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease, and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- A national recovery plans been prepared for the Regent Honeyeater (Menkhorst et al. 1999). The proposed development is not likely to interfere with the recovery of this species since the proposed landfill is not in a 'regularly-used region'. This species has not been recorded in the study area and the proposed development will entail minimal disturbance of potential habitat for this species.

Other critically endangered or endangered species

For the remaining potentially present species listed as critically endangered or endangered that occur within the New England Tablelands Bioregion the potential impacts of the proposed development are not likely to result in any of the points listed above as no suitable habitat exists in the study area. **The proposed development is not likely to have a significant impact on any critically endangered or endangered species**.

2. Impacts on Vulnerable species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate 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 vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

One vulnerable EPBC species, the Narrow-Leaved Black Peppermint *Eucalyptus nicholii*, was recorded in the study area. The proposed action may involve clearing a small section of the Gara TSR for an access easement in the vicinity of a small population (six adults and five juveniles) of *E. nicholii*.

Comment on important population criteria for *Eucalyptus nicholii*:

- The population on the study area is not considered to be a key source population either for breeding or dispersal since it presently consists of only six adult trees and five juveniles.
- The population on the study area is not considered to be a population that is necessary for maintaining genetic diversity since a significant population is known to occur approximately 10 km east of the study area along the Waterfall Way. Numerous records exist for this species in the Wildlife Atlas between 2 and 10 km east of the site along Waterfall Way.
- The population on the study area is not considered to be near the limit of the species range. This species is endemic to the Northern Tablelands of NSW where it occurs from Niangala in the south to Glen Innes in the north (Williams 1992; Brooker & Kleinig 1999; Hill 2002). A large population is reserved close to its western limit in Single National Park (30 km north-west of Guyra) while another significant population is known to occur approximately. 10 km east of the study area along the Waterfall Way.

The small population on the study area is not considered to be an important population.

Comments on Potential Impacts on *Eucalyptus nicholii*

- The proposed development is not likely to lead to long-term decrease in the size of an important population of *E. nicholii* since the population in the study area is not considered to be an important population and no mature trees or juveniles of this species will be removed.
- The proposed development is not likely to reduce the area of occupancy of an important population of *E. nicholii* since the population on the study area is not considered to be an important population and the proposed development will entail minimal disturbance of habitat for this species.
- The proposed development is not likely to fragment an existing important population into two or more populations since no trees or seedlings will be removed and clearing will take place on one side of the existing population only.
- The proposed development is not likely to adversely affect habitat critical to the survival of *E. nicholii* since no critical habitat has been identified for this species in the register maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of an important population of *E. nicholii* since the population on the study area is not considered to be an important population and the proposed development will entail minimal disturbance of habitat for this species.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *E. nicholii* is likely to decline since clearing and construction activities for the access road will allow for at least a 30 m buffer around the marked population of *E. nicholii* and an appropriate erosion and sedimentation control plan will be implemented during road construction.
- The proposed clearing for access through the TSR is not likely to result in invasive species that are harmful to the vulnerable species by becoming established in the vulnerable species' habitat since an appropriate ongoing weed control and monitoring program for invasive introduced species, particularly grasses, such as coolatai grass, African lovegrass, serrated tussock, and Chilean needlegrass will be implemented.
- The proposed development is not likely to introduce disease that may cause the species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease, and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- The proposed development is not likely to interfere with the recovery of *E. nicholii* since it will entail minimal disturbance of habitat for this species and no recovery plans been prepared for this species.

Other potentially present vulnerable species

An assessment of the likelihood of occurrence on the site of species listed in the EPBC Act (Table 5) indicated that three vulnerable plant species may have potential habitat occurring on the study area: *Bothriochloa biloba, Dichanthium setosum,* and *Thesium australe.*

- Potential habitat for the *Bothriochloa biloba, Dichanthium setosum,* and *Thesium australe* occurs on the study area in Box Gum Woodland on the portion of Gara TSR. Less than 1 ha of this habitat will be directly impacted by the proposed development for the construction of an access road.
- Potential habitat for the *Bothriochloa biloba* and *Dichanthium setosum* occurs on the partially cleared grassland on the study area. Approximately 6.5 ha of this habitat will be directly impacted by proposed development.

- Potential habitat for the *Bothriochloa biloba* and *Dichanthium setosum* occurs in New England Stringybark Woodland on the study area. Approximately 12.7 ha of this habitat will be directly impacted by proposed development for the staged construction of the landfill area.

Species present in the Box Gum Woodland (TSR)

Comments on Potential Impacts on vulnerable species, *Bothriochloa biloba, Dichanthium setosum*, and *Thesium australe*, likely to occur in the Box Gum Woodland on the Gara TSR:

- The proposed development is not likely to lead to long-term decrease in the size of potential important populations of these species since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to reduce the area of occupancy of important populations of these species since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to fragment an existing important population into two or more populations since these species have not been recorded on the study area.
- The proposed development is not likely to adversely affect habitat critical to the survival of these species since no critical habitat has been identified for these species in the register maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of an important population of these species since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline since the proposed action will involve minimal clearing of a small section (0.6 ha) of the Gara TSR for an access easement.
- The proposed development is not likely to result in invasive species that are harmful to one of these vulnerable becoming established in the species' habitat since weed management on the landfill site will include targeted monitoring and control of invasive species that may impact on potential habitat for these species.
- The proposed development is not likely to introduce disease that may cause these species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease, and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- The proposed development is not likely to interfere with the recovery of these species since they have not been recorded on the study area and the proposed development will entail minimal disturbance of potential habitat.

Species present in the cleared grassland

Comments on Potential Impacts on vulnerable species, *Bothriochloa biloba* and *Dichanthium setosum*, likely to occur on the partially cleared grassland on the study area

- The proposed development is not likely to lead to long-term decrease in the size of potential important populations of these species since the history of heavy grazing would greatly reduce the chances these species occurring on the study area.

- The proposed development is not likely to reduce the area of occupancy of important populations of these species since the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to fragment existing important populations into two or more populations since the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to adversely affect habitat critical to the survival of these species since no critical habitat has been identified for these species in the register maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of important populations of these species since they have not been recorded on the study area and the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline since they have not been recorded on the study area and the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to result in invasive species that are harmful to any of these vulnerable species becoming established in their habitat since weed management on the landfill site will include targeted monitoring and control of invasive species that may impact on potential habitat for these species.
- The proposed development is not likely to introduce disease that may cause these species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease, and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- The proposed development is not likely to interfere with the recovery of these species as the history of heavy grazing would greatly reduce the chances these species occurring on the study area and no recovery plans been prepared for these species.

Species present in the Stringybark Woodland

Comments on Potential Impacts on vulnerable species, *Bothriochloa biloba* and *Dichanthium setosum* likely to occur in the New England Stringybark Woodland on the study area

- The proposed development is not likely to lead to long-term decrease in the size of potential important populations of these species since the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to reduce the area of occupancy of important populations of these species since they have not been recorded on the study area.
- The proposed development is not likely to fragment existing important populations into two or more populations since these species have not been recorded on the study area.
- The proposed development is not likely to adversely affect habitat critical to the survival of these species since no critical habitat has been identified for these species in the register maintained by Federal Minister for the Environment.
- The proposed development is not likely to disrupt the breeding cycle of important populations of these species since they have not been recorded on the study area and the history of heavy grazing would greatly reduce the chances these species occurring on the study area.
- The proposed development is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline

since they have not been recorded on the study area and the history of heavy grazing would greatly reduce the chances these species occurring on the study area.

- The proposed development is not likely to result in invasive species that are harmful to any of these vulnerable species becoming established in the habitat since weed management on the landfill site will include targeted monitoring and control of invasive species that may impact on potential habitat for these species.
- The proposed development is not likely to introduce disease that may cause these species to decline since strict protocols will be adhered to during the construction and operational phases of the landfill development to prevent the transmission or introduction of disease, and the public will not have access to the site. Appropriate contingency plans to deal with outbreaks that may be detected at some point in time will include schedules for monitoring disease during the operation of the landfill facility and for a nominal period of at least 5 years after rehabilitation works and decommissioning of the site.
- The proposed development is not likely to interfere with the recovery of these species the history of heavy grazing would greatly reduce the chances these species occurring on the study area and no recovery plans been prepared for these species.

Assessment of the habitat requirements of other vulnerable species in the New England Tablelands Bioregion, the quality of habitat on the study area, and the design of the proposed development suggests that the potential impacts of the proposed development are not likely to result in any of the points listed above. **The proposed development is not likely to have a significant impact on any vulnerable species.**

3. Critically endangered and endangered ecological communities

Significant impact criteria

An action is likely to have a significant impact on a critically endangered (CE) or EEC if there is a real chance or possibility that it will:

- reduce the extent of an ecological community;
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- adversely affect habitat critical to the survival of an ecological community;
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
- assisting invasive species, that are harmful to the listed ecological community, to become established;
- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or
- interfere with the recovery of an ecological community.
-

The CE ecological Box Gum Woodland occurs on the study area. It is proposed to clear a small section (0.6 ha) of this community for the landfill access.

Comments on Potential Impacts on critically endangered ecological community, *Box Gum Woodland* occurring on the study area

- The proposed clearing is likely to reduce the extent of the Box Gum Woodland community by less than 1 ha.
- The proposed clearing for the 30 m wide access route through the Gara TSR will create a linear separation between a 3 ha patch of Box Gum Woodland to the west and a 27 ha patch of Box Gum Woodland to the east.
- The proposed clearing is not likely to adversely affect habitat critical to the survival of an ecological community since the strip to be cleared is in an area that has previously been cleared.
- The proposed clearing is not likely to modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival since drainage and erosion control measures will be incorporated into design and construction of the access road.
- The proposed clearing is not likely to cause a substantial change in the species composition of an occurrence of an ecological community since the proposed mitigation measures and remnant vegetation conservation management plan will minimise negative impacts on *E. nicholii* in this patch of Box Gum Woodland.
- The proposed clearing is not likely to assist invasive species that are harmful to the Box Gum Woodland to become established since weed management on the landfill site will include targeted monitoring and control of invasive species that may impact on potential habitat for this ecological community.
- The proposed clearing is not likely to cause regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the

growth of species in the ecological community since stringent pollution controls to deal with these threats will be in place for the entire operational life of the landfill development (including the access through the TSR).

- The proposed clearing is not likely to interfere with the recovery of Box Gum Woodland since the proposed mitigation measures and vegetation management plan will minimise negative impacts on this patch of Box Gum Woodland. A recovery plan has not been prepared for this CE ecological community.

The implementation of mitigation measures and vegetation management plans for the proposed development will minimise impacts on Box Gum Woodland.

4. World Heritage Values

The study area lays approximately 4 km north-north-west of the Oxley Wild Rivers National Park.

Oxley Wild Rivers National Park is listed on the Register of World Heritage sites in recognition of the extensive dry rainforest that occurs within the park and the associated rich biodiversity that includes several rare or threatened plants and animals. The park is part of the Central Eastern Rainforest Reserves of Australia (CERRA) which includes more than 50 different reserves from south-east Queensland to the Hunter Valley. The CERRA listing covers the most extensive areas of sub-tropical rainforest in the world, large areas of warm temperate rainforest, and nearly all of Australia's remaining Antarctic beech cool temperate rainforest. These reserves complement other Australian World Heritage rainforests in the wet tropics of far north Queensland and in Tasmania.

An action has, will have, or is likely to have a significant impact on a World Heritage Area if it does, will, or is likely to:

- modify or inhibit ecological processes in a World Heritage property;
- reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property;
- fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property;
- cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property; and/or
- fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property.

Comments on Potential Impacts on World Heritage Values

The assessment of significance for the proposed development has considered known and potentially occurring threatened species within 20 km of the study area. This extensive area includes portions of the Oxley Wild Rivers National Park which is part of the World Heritage listed Central Eastern Rainforest Reserves of Australia. No specific impacts on individual threatened species or endangered ecological communities that may occur in the World Heritage area have been identified in this assessment.

The landfill facility will be constructed and operated in a manner that avoids significant off-site impacts from ground and surface water contamination or spread of weeds and pests on the Oxley Wild Rivers National Park World Heritage Area.

5. Impacts on Migratory or Listed Marine Species

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species;
- result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.
-

An area of important habitat is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- habitat utilised by a migratory species which is at the limit of the species range; or
- habitat within an area where the species is declining.

Habitat means the biophysical medium or media:

- occupied (continuously, periodically or occasionally) by an organism or group of organisms; or
- once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced.

Migratory or Listed Marine Species Recorded On or Adjacent to the Study Area

No bird species on site listed as migratory or listed marine species under the EPBC Act were recorded on the study area. The proposed development, therefore, is not likely to have a significant impact on the migratory or listed marine species detected on the study area.

Migratory Species Listed on the EPBC Protected Matters Search Tool

Of the migratory species likely to occur within a twenty kilometre radius of the study area (Table 10) only the White-throated Needletail, Regent Honeyeater, Fork-tailed Swift, White Egret, Cattle Egret and Rainbow Bee-eater are considered to have potential habitat on the study area.

Potential Habitat for White-throated Needletail on the study area:

The White-throated Needletail may forage in the airspace above the study area. This species is an aerial insectivore that occurs throughout eastern and northern Australia during summer, and breeds in northern Asia during the Australian winter (Higgins 1999). The population of this species in NSW is stable with no contraction of distribution likely since European settlement (NPWS 2000).

This species does not breed on the study area. The scale of the proposal will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal is not likely to have a significant impact on this species.

Potential Habitat for Fork-tailed Swift on the study area:

The Fork-tailed Swift could forage in the airspace above the study area. This species is an aerial insectivore that is more common in Western and South Australia than in south-eastern Australia during summer. Breeds in northern Asia during the Australian winter (Higgins 1999).

This species will not breed on the study area. The scale of the proposal will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal is not likely to have a significant impact on the Fork-tailed Swift.

Potential Habitat for Regent Honeyeater on the study area:

The Regent Honeyeater could forage in the Box Gum Woodland in the study area when eucalypts are in flower. Regent Honeyeaters are generally found in dry open forest and woodlands in areas of low to moderate relief with abundant nectar producing eucalypts. They spend much of their time feeding on the nectar from eucalypts such as the Mugga Ironbark, White Box and Yellow Box, and Blakeley's Red Gum on which they are reliant.

Regent Honeyeaters breed in spring/summer on the inland slopes of the Great Dividing Range and would probably not breed in the study area. The removal of 0.6 ha of Box Gum Woodland from the TSR, where the species has not been recorded in our surveys or historically, will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal is not likely to have a significant impact on this species.

Potential Habitat for White Egret on the study area:

The White Egret could forage in the sedgeland along the shallow drainage lines or moist areas around the two small dams on the study area. White Egrets are cosmopolitan throughout most of Australia.

White Egrets nest in treetop colonies over water. Since there are no trees associated with the dams or drainage lines on the study area they probably would not breed in the study area. The scale of the proposal will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal is not likely to have a significant impact on the White Egret.

Potential Habitat for Cattle Egret on the study area:

The Cattle Egret could forage in the cleared grassland and partially cleared woodland on the study area wherever cattle may be grazing. Cattle Egrets arrived in Australia in the early 1900’s and have spread throughout most of Australia since that time.

Cattle Egrets nest in treetops over water. Since there are no trees associated with the dams or drainage lines on the study area it is unlikely that they would breed on study area. The scale of the proposal will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal is not likely to have a significant impact on the Cattle Egret.

Potential Habitat for Rainbow Bee-eater on the study area:

Rainbow Bee-eaters forage on flying insects in open country and could potentially forage in the cleared grassland and partially cleared woodland on the study area. Rainbow Bee-eaters are seasonal migrants that occur throughout most of Australia except in cooler wetter forested areas. Rainbow Bee-eaters are ground nesting and breed in summer in southern Australia. In winter they migrate to northern Australia and Asia.

The scale of the proposal will not affect an important area of habitat for this species, or disrupt the lifecycle of an ecologically significant proportion of its population. The proposal, therefore, is not likely to have a significant impact on the Rainbow Bee-eater.

Comment on Potential Impacts on Migratory Species

- The proposed development is not likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species discussed above.
- The study area does not represent important habitat for any of the migratory or listed marine species discussed above. Thus, the proposed development is not likely to result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.
- The study area is not likely to support a potentially ecologically significant proportion of the population for any of the migratory or listed marine species discussed above. Thus the proposed development is not likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

EPBC Assessment

A summary of the impact of the proposed activity on matters of National Environmental Significance is presented below.

Significant impacts may result from: i) the proximity of the World Heritage Area Oxley Wild Rivers National Park, which is located 4 km downstream of the proposed landfill site; and, ii) the proposed clearing of a portion of the CE ecological community Box Gum Woodland.

Potential for significant impact:

a) The landfill facility will be constructed and operated in a manner that avoids significant off-site impacts from ground and surface water contamination or spread of weeds and pests on the Oxley Wild Rivers National Park World Heritage Area.

b) The proposed access route will fragment a patch of the CE ecological community Box Gum Woodland which includes a small population of the vulnerable species narrow-leaved peppermint *E. nicholii*. Potential adverse impacts on *E. nicholii* that could result from the proposed clearing and construction of an access route through the TSR will be minimised by: 1) avoiding clearing within a 30 m buffer of the marked population; 2) implementation of appropriate erosion and sedimentation control during road construction; and 3) ongoing weed control and monitoring of invasive weeds, particularly introduced grasses such as coolatai grass, African lovegrass, serrated tussock, and Chilean needlegrass.

c) The proposed clearing for an access route will result in the loss of approximately 0.6 ha of the CE ecological community Box Gum Woodland that occurs on the TSR. Land clearance is listed as a Key Threatening Process under the EPBC Act

The particular manner (*sensu* DEH 2003) in which the proposed mitigation measures and management plans will be implemented will ensure that impacts on matters protected under the EPBC Act are avoided or mitigated to the extent that significant impacts will not occur.

Referral Recommendation

The proposed development will require referral to the Commonwealth Minister for the Environment for consideration under the EPBC Act because the development may cause the following significant impacts on a matter of national environmental significance:

(i) clearing of up to 1ha of the CE ecological community, Box Gum Woodland and derived grassland;

(ii) potential isolation of a population of the vulnerable species, narrow-leaved peppermint *Eucalyptus nicholii*; and

(iii) the potential for long-term off-site impacts from the operation of the landfill on the Oxley Wild Rivers National Park, part of the Central Eastern Rainforest Reserves of Australia World Heritage Area..

Appendix C. Flora Survey Results

Table 14. Flora species observed at the study area on 3 April 2005, 15 October 2005 and 18 September 2006.

V=Vulnerable Species (TSC act and EPBC Act); R=ROTAP species; TSR=Travelling Stock Reserve; *= introduced species, **= exotic species listed as noxious weeds for the Armidale Dumaresq LGA.

Status	Scientific name	Common name	Study site	TSR
	Trees			
	Acacia filicifolia	Fern-Leaved Wattle	✓	✓
	Allocasuarina littoralis	Black She-Oak	✓	
	Banksia integrifolia subsp*. monticola*	Banksia		✓
	Angophora floribunda	Rough-barked Apple		✓
	Eucalyptus blakelyi	Blakelys Red Gum	✓	✓
	Eucalyptus bridgesiana	Apple-topped Box		✓
	Eucalyptus caliginosa	New England Stringybark	✓	✓
R	***Eucalyptus elliptica***	Bendemeer White Gum		✓
	Eucalyptus melliodora	Yellow Box	✓	✓
V	***Eucalyptus nicholii***	Narrow-leaved Black Peppermint		✓
	Exocarpus cuppresiformis	Native Cherry		✓
	Shrubs			
	Acacia dawsonii	Poverty Wattle		✓
	Acacia ulicifolia	Prickly Moses	✓	✓
	Bursaria spinosa subsp. *spinosa*	Blackthorn	✓	✓
	Cassinia laevis	Cough Bush	✓	✓
	Cassinia quinquefaria	Cough Bush	✓	✓
*	*Crataegus monogyna*	Hawthorn	✓	✓
	Cryptandra amara	Bitter Cryptandra		✓
	Cryptandra propinqua	Cryptandra		✓
	Daviesia genistifolia	Broom Bitter Pea	✓	✓
	Daviesia latifolia	Broad-leaved Bitter Pea	✓	✓
	Dillwynia sieberi	Spiny Parrot Pea		✓
	Grevillea juniperina	Juniper-leaved Grevillea		✓
	Hibbertia linearis	Guinea Flower	✓	
	Hibbertia obtusifolia	Guinea Flower	✓	✓
	Hibbertia riparia	Guinea Flower	✓	✓
	Hovea linearis	Hovea		✓
	Indigofera australis	Hill Indigo	✓	✓
	Jacksonia scoparia	Dogwood	✓	✓
	Lespedeza juncea subsp. *sericea*	Chinese Lespedeza		✓
	Lissanthe strigosa	Peach Heath	✓	✓
	Maytenus silvestris	Narrow-leaved Orangebark		✓
	Melichrus urceolatus	Urn Heath		✓
	Olearia viscidula	Sticky Daisy Bush		✓
	Phyllanthus virgatus	Small Spurge	✓	

	Pimelea curviflora var. *divergens*	Curved Riceflower	✓	✓
	Pultenaea microphylla	Spreading Bush-Pea	✓	✓
**	*Rosa rubiginosa*	Sweet Briar	✓	✓
**	*Rubus fruticosus* s.l.	Blackberry	✓	✓
	Rubus parvifolius	Native Raspberry	✓	✓
	Vines/climbers			
	Glycine clandestina	Glycine	✓	✓
	Glycine tabacina	Variable Glycine	✓	✓
	Hardenbergia violacea	Purple Twining-Pea		✓
	Mistletoes			
	Amyema micquelii	Mistletoe		✓
	Amyema pendulum	Drooping Mistletoe	✓	✓
	Grasses			
	Aristida ramosa	Purple Wiregrass	✓	✓
	Aristida vagans	Wiregrass	✓	✓
	Austrodanthonia laevis	Wallaby Grass	✓	✓
	Austrodanthonia racemosa var. *racemosa*	Slender Wallaby Grass	✓	✓
	Austrodanthonia richardsonii	Wallaby Grass	✓	
	Austrostipa rudis	Tall Speargrass	✓	✓
	Austrostipa scabra subsp. *scabra*	Rough Speargrass	✓	✓
	Bothriochloa decipiens	Red-leg Grass	✓	
	Bothriochloa macra	Red-leg Grass	✓	✓
*	*Briza minor*	Quivering Grass	✓	
	Chloris ventricosa	Tall Chloris	✓	
*	*Chloris virgata*	Feathertop Rhodes Grass	✓	
	Cymbopogon refractus	Barb-wire Grass	✓	✓
	Cynodon dactylon	Couch	✓	
	Dichelachne micrantha	Slender Plume Grass	✓	✓
	Echinopogon caespitosus var. *caespitosus*	Hedgehog Grass	✓	✓
*	*Eleusine tristachya*	Goose Grass	✓	
	Elymus scaber	Wheat Grass	✓	✓
*	*Enneapogon nigricans*	Niggerheads	✓	
**	*Eragrostis curvula*	African Lovegrass	✓	✓
	Eragrostis leptostachya	Small Lovegrass	✓	✓
	Eragrostis molybdea	Lovegrass	✓	✓
	Lachnagrostis avenaceus	Blown Grass	✓	✓
	Microlaena stipoides var. *stipoides*	Meadow Rice Grass	✓	✓
	Panicum effusum	Hairy Panic	✓	✓

*	*Paspalum dilatatum*	Paspalum	✓	
	Paspalum distichum	Water Couch	✓	
	Pennisetum allopecuroides	Swamp Foxtail	✓	
	Poa sieberiana	Snow Grass	✓	✓
*	*Setaria gracilis*	Pigeon Grass	✓	
	Sarga leiocladum	Native Sorghum	✓	✓
	Sporobolus creber	Slender Rat's Tail Grass	✓	✓
	Themeda australis	Kangaroo Grass	✓	✓
	Herbs			
	Acaena ovina	Sheep's Burr		✓
*	*Acetosella vulgaris*	Wood Sorrel	✓	✓
	Ajuga australis	Austral Bugle		✓
*	*Anagallis arvensis*	Scarlet Pimpernell	✓	✓
	Asperula conferta	Woodruff	✓	✓
*	*Aster subulatus*	Wild Aster	✓	✓
	Bidens subalternans	Greater Beggar's Ticks		✓
	Brachycome nova-anglica	New England Brachycome		✓
	Brunoniella australis	Blue Trumpet		✓
	Bulbine bulbosa	Bulbine Lily		✓
	Calotis cuneifolia	Purple Burr-daisy	✓	✓
	Calotis lappulacea	Tangled Burr-daisy	✓	
	Carex appressa	Tall Sedge	✓	✓
	Carex breviculmis	A Small Sedge		✓
*	*Centaurium erythraea*	Common Centaury	✓	✓
	Centella asiatica	Pennywort	✓	
	Centipeda minima	Spreading Sneezeweed	✓	
	Cheilanthes distans	Hairy Mulga Fern	✓	
	Cheilanthes sieberi subsp. *sieberi*	Poison Mulga Fern	✓	✓
	Chrysocephalum apiculatum	Clustered Everlasting	✓	✓
*	*Cirsium vulgare*	Spear Thistle	✓	✓
*	*Conyza bonariensis*	Flaxleaf Fleabane	✓	✓
	Craspedia canens	Grey Billy-buttons		✓
	Crassula sieberiana	Australian Stonecrop		✓
	Cymbonotus lawsonianus	Bear’s Ear	✓	✓
	Cynoglossum australe	Native forget-me-not		✓
*	*Cyperus eragrostis*	Umbrella Sedge	✓	✓
	Cyperus gracilis	Slender Sedge	✓	✓
	Cyperus lhotskyanus	Sedge	✓	
	Cyperus sanguinolentus	Sedge		✓
	Cyperus sphaeroideus	Sedge	✓	✓
	Desmodium brachypodum	Large Tick-trefoil	✓	✓
	Desmodium gunnii	Tick-trefoil	✓	✓
	Desmodium varians	Slender Tick-trefoil	✓	✓

	Dianella revoluta var. *vinosa*	Flax Lily		✓
	Dichondra sp. A	Kidney Weed	✓	✓
	Dipodium sp.	Hyacinth Orchid		✓
	Diuris chrysantha	Donkey Orchid		✓
	Elatine gratioloides	Waterwort	✓	
	Eleocharis acuta	Spikerush	✓	✓
	Euchiton sphaericus	Cudweed	✓	✓
	Fimbristylis dichotoma	Common Fringe-sedge	✓	✓
*	*Gamochaeta spicata*	Spiked Cudweed	✓	✓
	Geranium solanderi var. *solanderi*	Native Geranium	✓	✓
	Goodenia hederacea subsp. *hederacea*	Ivy Goodenia	✓	✓
	Goodenia pinnatifida	Goodenia	✓	✓
	Haloragis heterophylla	Raspwort	✓	✓
	Hydrocotyle laxiflora	Stinking pennywort		✓
	Hypericum gramineum	Small St. John's Wort	✓	✓
*	*Hypochaeris radicata*	Catsear	✓	✓
	Hypolepis glandulifera	Downy Ground-fern	✓	
	Isolepis sp.	Small Clubrush	✓	✓
	Juncus filicaulis	Rush		✓
	Juncus planifolius	Broad Rush		✓
	Juncus sp.	Rush	✓	✓
	Juncus usitatus	Rush	✓	✓
*	*Lepidium africanum*			✓
	Leptorynchos squamatus	Yellow Buttons		✓
	Lomandra filiformis	Slender Mat-rush	✓	✓
	Lomandra longifolia	Spiny Mat-rush		✓
	Mentha diemenica	Pennyroyal	✓	✓
	Opercularia hispida	Hairy Stinkweed		
	Orchid - ground	unknown sp, rosette lvs		✓
	Oxalis exilis	Soursob	✓	✓
*	*Paronychia brasiliana*	Chilean Whitlow Wort	✓	✓
	Pellaea falcata	Sickle Fern	✓	
	Persicaria lapathifolia	Knotweed	✓	
	Persicaria prostrata	Spreading Knotweed	✓	✓
*	*Petrorhagia nanteulii*			✓
*	*Phytolacca octandra*	Inkweed	✓	
	Plantago gaudichaudii	Slender Plantain		✓
*	*Plantago lanceolata*	Lamb's Tongue	✓	✓
	Podolepis sp.	Copper Daisy		✓
*	*Polygonum aviculare*	Wireweed	✓	
	Poranthera microphylla	A Euphorb		✓
	Ranunculus lappaceus	Common Buttercup		✓
	Ranunculus pumilio	Small Buttercup	✓	
	Rumex brownii	Swamp Dock	✓	✓

*	*Sanguisorba minor*	Salad Burnet		✓
	Scleranthus biflorus	Knawel		✓
	Senecio gunnii	A senecio		✓
	Stackhousia monogyna	Creamy Candles	✓	✓
*	*Taraxacum officinale*	Dandelion		✓
*	*Trifolium campestre*	Hop Clover	✓	
*	*Trifolium repens*	White Clover		✓
	Triptilodiscus pygmaeus	Small Sunray	✓	
	Typha orientalis	Broad-leaved Cumbungi		✓
	Urtica incisa	Stinging Nettle	✓	✓
*	*Urtica urens*	Stinging Nettle	✓	
*	*Verbascum thapsus*	Great Mullein	✓	
*	*Verbascum virgatum*	Green Mullein		✓
*	*Verbena bonariensis*	Purple Top	✓	✓
	Veronica plebeia	Trailing Speedwell		✓
	Viola betonicifolia	Native Violet		✓
	Vittadinia muelleri	Dissected Fuzzweed		✓
	Vulpia bromoides	Squirrel Tail Fescue		
	Wahlenbergia communis	Bluebell	✓	✓
**	*Xanthium spinosum*	Bathurst Burr	✓	
	Aquatic plants			
	Ottelia ovalifolia	Swamp Lily	✓	
	Vallisneria gigantea	Ribbonweed	✓	

Appendix D. Fauna Survey Results

Table 15. Birds observed on the study area on 29-30 March 2005, 18-19 October 2005, 18 September 2006 and 23-24 November 2009.
* = Introduced, TSC-V = Vulnerable Species TSC Act, PD = Preliminary Determination for TSC-V

Common Name	**Scientific Name**	**Autumn 2005**		**Spring 2005**		**Spring 2006**	**Spring 2009**	
		LS	**TSR**	**LS**	**TSR**	**TSR**	**LS**	**TSR**
Australasian Grebe	*Tachybaptus novaehollandiae*	X		X			X	
Australasian Pipit	*Anthus novaeseelandiae*	X		X			X	
Australian Magpie	*Cracticus tibicen*	X	X	X	X	X	X	X
Australian Owlet-nightjar	*Aegotheles cristatus*					X	X	
Australian Raven	*Corvus coronoides*	X	X	X	X	X	X	
Australian Wood Duck	*Chenonetta jubata*			X			X	
Barn Owl	*Tyto alba*		X					
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	X	X	X	X	X		X
Brown Falcon	*Falco berigora*	X						X
Brown Goshawk	*Accipiter fasciatus*	X		X	X	X	X	
Brown Thornbill	*Acanthiza pusilla*							X
Brown-headed Honeyeater	*Melithreptus brevirostris*	X		X	X	X	X	X
Brush Cuckoo	*Cacomantis variolosus*				X			
Buff-rumped Thornbill	*Acanthiza reguloides*	X	X	X	X	X	X	X
*Common Starling	*Sturnus vulgaris*	X		X		X	X	
Crested Pigeon	*Ocyphaps lophotes*	X		X				
Crested Shrike-tit	*Falcunculus frontatus*				X			
Crimson Rosella	*Platycercus elegans*	X			X	X		X
Diamond Firetail (TSC-V)	***Stagonopleura guttata***	**X**		**X**	**X**	**X**		
Dusky Woodswallow	*Artamus cyanopterus*	X	X	X	X	X	X	X
Eastern Rosella	*Platycercus eximius*	X	X	X	X	X	X	X
Eastern Spinebill	*Acanthorhynchus tenuirostris*	X	X	X	X	X	X	X
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	X						
Forest Raven	*Corvus tasmanicus*	X	X	X	X	X		X
Fuscous Honeyeater	*Lichenostomus fuscus*		X	X	X	X		X
Galah	*Cacatua roseicapilla*	X	X	X	X			
Golden Whistler	*Pachycephala pectoralis*	X						
Grey Butcherbird	*Cracticus torquatus*	X	X	X	X	X	X	X
Grey Fantail	*Rhipidura fuliginosa*	X	X	X	X	X	X	X
Grey Shrike-thrush	*Colluricincla harmonica*	X	X	X	X	X		X
Grey Teal	*Anas gracilis*	X					X	
Jacky Winter	*Microeca fascinans*	X			X	X		
Laughing Kookaburra	*Dacelo novaeguineae*	X	X	X	X	X	X	X
Leaden Flycatcher	*Myiagra rubecula*			X	X	X	X	X
Little Eagle (PD)	***Hieraaetus morphnoides***	**X**		**X**			**X**	**X**
Magpie-lark	*Grallina cyanoleuca*	X		X		X	X	
Masked Lapwing	*Vanellus miles*	X						
Mistletoebird	*Dicaeum hirundinaceum*	X	X	X	X	X	X	X

Common Name	**Scientific Name**	**Autumn 2005**		**Spring 2005**		**Spring 2006**	**Spring 2009**	
		LS	**TSR**	**LS**	**TSR**	**TSR**	**LS**	**TSR**
Noisy Friarbird	*Philemon corniculatus*	X	X	X	X	X	X	X
Noisy Miner	*Manorina melanocephala*	X	X	X	X	X	X	X
Olive-backed Oriole	*Oriolus sagittatus*	X		X	X			X
Pacific Black Duck	*Anas superciliosa*	X		X				
Pallid Cuckoo	*Cacomantis pallidus*				X			
Pied Butcherbird	*Cracticus nigrogularis*		X					
Pied Currawong	*Strepera graculina*		X					
Rainbow Lorikeet	*Trichoglossus haematodus*		X					
Red Wattlebird	*Anthochaera carunculata*		X	X	X	X		X
Red-rumped Parrot	*Psephotus haematonotus*	X	X	X	X	X	X	
Restless Flycatcher	*Myiagra inquieta*	X		X			X	
Rufous Songlark	*Cinclorhamphus mathewsi*							X
Rufous Whistler	*Pachycephala rufiventris*	X	X	X	X	X	X	X
Sacred Kingfisher	*Todiramphus sanctus*				X			X
Scarlet Robin (PD)	***Petroica multicolor***		**X**	**X**	**X**		**X**	
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	X		X				
Silvereye	*Zosterops lateralis*					X		
Southern Boobook	*Ninox noveseelandiae*						X	
Speckled Warbler (TSC-V)	***Chthonicola sagittata***	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Spotted Pardalote	*Pardalotus punctatus*	X	X		X	X	X	X
Straw-necked Ibis	*Threskiornis spinicollis*		X					
Striated Pardalote	*Pardalotus striatus*	X	X	X	X	X	X	X
Striated Thornbill	*Acanthiza lineata*	X	X	X	X	X	X	X
Superb Fairy-wren	*Malurus cyaneus*	X	X	X			X	X
Tawny Frogmouth	*Podargus strigoides*	X	X	X	X	X		
Torresian Crow	*Corvus orru*	X			X			
Varied Sittella (PD)	***Daphoenositta chrysoptera***	**X**	**X**	**X**	**X**	**X**	**X**	
Wedge-tailed Eagle	*Aquila audax*	X						X
Weebill	*Smicrornis brevirostris*		X		X	X		X
Welcome Swallow	*Hirundo neoxena*	X		X	X		X	
Whistling Kite	*Haliastur sphenurus*						X	
White-eared Honeyeater	*Lichenostomus leucotis*	X	X	X		X		
White-naped Honeyeater	*Melithreptus lunatus*			X	X	X	X	
White-necked Heron	*Ardea pacifica*		X					
White-throated Gerygone	*Gerygone olivacea*	X	X	X	X	X	X	X
White-throated Needletail	*Hirundapus caudacutus*							X
White-throated Treecreeper	*Cormobates leucophaeus*	X	X	X	X	X	X	X
White-winged Chough	*Corcorax melanoramphos*	X	X			X		X

Common Name	Scientific Name	Autumn 2005		Spring 2005		Spring 2006	Spring 2009	
		LS	**TSR**	**LS**	**TSR**	**TSR**	**LS**	**TSR**
White-winged Triller	*Lalage sueurii*			X			X	X
Willie Wagtail	*Rhipidura leucophrys*	X	X	X	X	X		X
Yellow Thornbill	*Acanthiza nana*	X		X			X	
Yellow-faced Honeyeater	*Lichenostomus chrysops*		X	X	X	X	X	X
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	X	X	X	X		X	X

Table 16. Mammals detected at the study area on 29-30 March 2005, 18-19 October 2005, and 18 September 2006.
*=Introduced, #=Listed Key Threatening Process, TSC-V = Vulnerable Species TSC Act

Common Name	Species Name	Observation Type
Common Brushtail Possum	*Trichosurus vulpecula*	Spotlight
Eastern Bent wing Bat (TSC-V)	*Miniopterus schreibersii oceanensis*	Anabat detector (P)
Eastern Grey Kangaroo	*Macropus giganteus*	Daytime observation / Spotlight
Fox*#	*Vulpes vulpes*	Spotlight
Gould’s wattled bat	*Chalinolobus gouldii*	Anabat detector (C)
Hare*	*Lepus capensis*	Spotlight
House Mouse*	*Mus domesticus*	Spotlight
Koala (TSC-V)	***Phascolarctos cinereus***	Spotlight
Large forest bat	*Vespadelus darlingtoni*	Anabat detector (P)
Little forest bat	*Vespadelus vulturnus*	Anabat detector (P)
Long-eared bat	*Nyctophilus* spp. *(*Either *N. geoffroyii* or *N. gouldi)*	Anabat detector (C)
Rabbit*#	*Oryctolagus cuniculus*	Daytime observation / Spotlight
Short-beaked Echidna	*Tachyglossus aculeatus*	Daytime observation
Sugar Glider	*Petaurus breviceps*	Spotlight
White-striped Freetail-Bat	*Nyctinomus australis*	Vocal Call and Anabat detector (C)

Table 17. Microbat call attributes used to distinguish between species. 2006.

Species Name	Species with similar calls	Attributes used for Identification
Miniopterus schreibersii oceanensis	*Vespadelus darlingtoni.*	Down sweeping tail on some pulses; Uneven pulse shape and time between pulses within call sequence.
Chalinolobus gouldii	*Scotorepens balstoni*	Pulse length > 10ms; and site is located east of the Divide.
	Mormopterus spp.	Consecutive pulses alternate in frequency;
Vespadelus darlingtoni	*Miniopterus schreibersii*	Lacks down sweeping tail
Vespadelus vulturnus	*Vespadelus regulus*	Characteristic Frequency > 47 kHz
	Vespadelus troughtoni	Variation in call frequency and site is located east of the Divide
	Chalinolobus morio	Lacks down sweeping tail; Lacks alternation in shape of consecutive pulses
Nyctophilus spp.(either *N. geoffroyii* or *N. gouldi*)	*Myotis adversus*	Initial slope < 300 Octaves per second (OPS).
	Nyctophilus bifax	Outside of known range (coastal plains of north-east NSW)
	Nyctophilus timoriensis	Outside of known range (western slopes and plains of NSW) Note: It is not possible to distinguish between *Nyctophilus spp*. using ANALOOK (Pennay *et al.* 2004).

Table 18. Frogs detected at the study area on 29-30 March 2005, 18-19 October 2005, and 18 September 2006

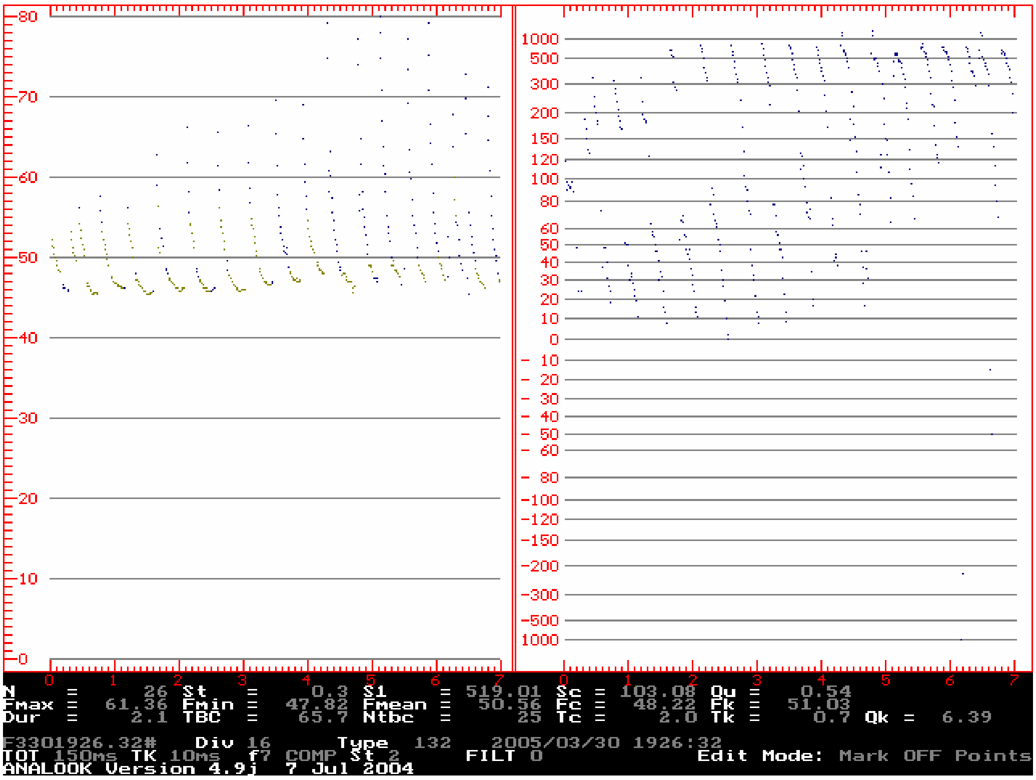
Common Name	Species Name
Plains Froglet	*Crinia parinsignifera*
Eastern Froglet	*Crinia signifera*
Eastern Banjo Frog	*Limnodynastes dumerilii*
Spotted Grass-Frog	*Limnodynastes tasmaniensis*
Smooth Toadlet	*Uperoleia laevigata*
Bleating Tree-Frog	*Litoria dentata*
Whistling Tree-Frog	*Litoria verreauxii*
Broad-palmed Frog	*Litoria latopalmata*

Table 19. Reptiles detected at the study area on 29-30 March 2005, 18-19 October 2005, and 18 September 2006

Common Name	Species Name
Boulenger's Skink	*Morethia boulengeri*
Eastern Bluetongue	*Tiliqua scincoides*
Eastern Snake-necked Turtle	*Chelodina longicollis*
Garden Skink	*Lampropholis delicata*
Grass Skink	*Lampropholis guichenoti*
Three-toed Earless Skink	*Hemiergis decresiensis*
Tree Dragon	*Amphibolurus muricatus*
Tree Skink	*Egernia striolata*
Two-toed Worm-Skink	*Anomalopus leuckartii*
Wall Skink	*Cryptoblepharus virgatus*

Appendix E. Frequency vs Time Graphs for Recorded Microbats

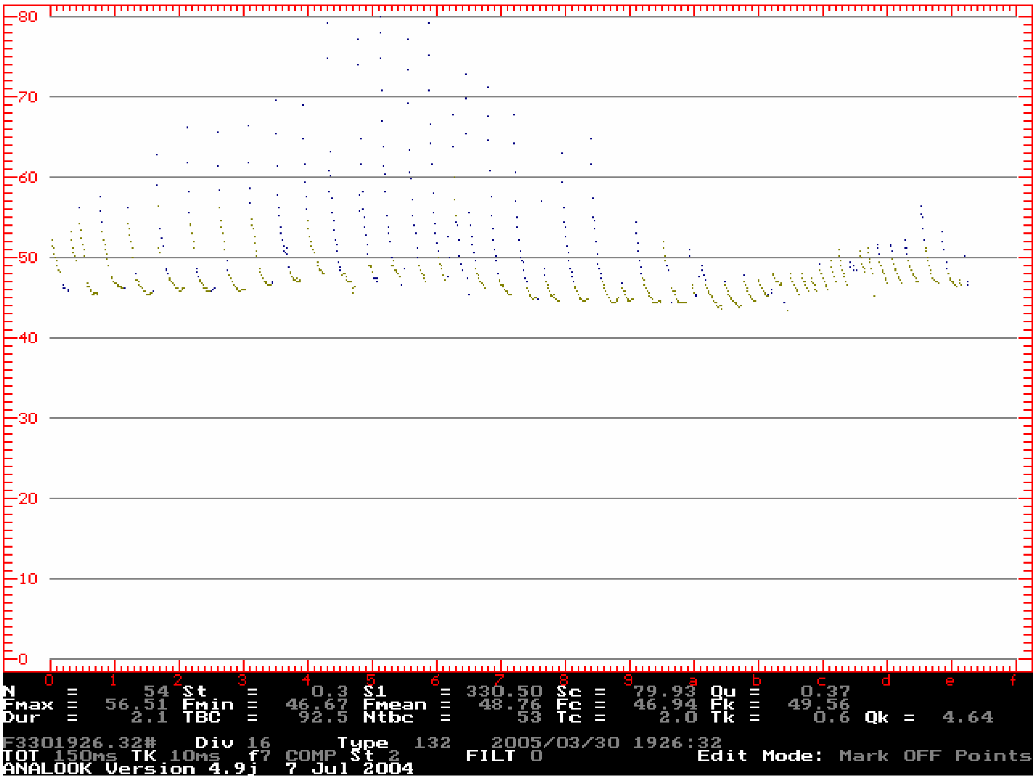
Bat calls recorded by ANABAT were identified using ANALOOK 4.9j software (Corben 2004) with reference to Pennay *et al*. (2004) and Reinhold *et al*. (2001). Call identification is based on the following levels of confidence: (C) – Confident, (P) – Probable. Bat taxonomic nomenclature and common names follow those of Churchill (1998).



```
N     =     26 St   =     0.3 S1     = 519.01 Sc = 103.08 Qu =   0.54
Fmax  =  61.36 Fmin =   47.82 Fmean  =  50.56 Fc =  48.22 Fk =  51.03
Dur   =    2.1 TBC  =    65.7 Ntbc   =     25 Tc =    2.0 Tk =    0.7 Qk =   6.39

F3301926.32#   Div 16     Type  132   2005/03/30 1926:32
TOT 150ms TK 10ms  f7 COMP St 2     FILT 0           Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

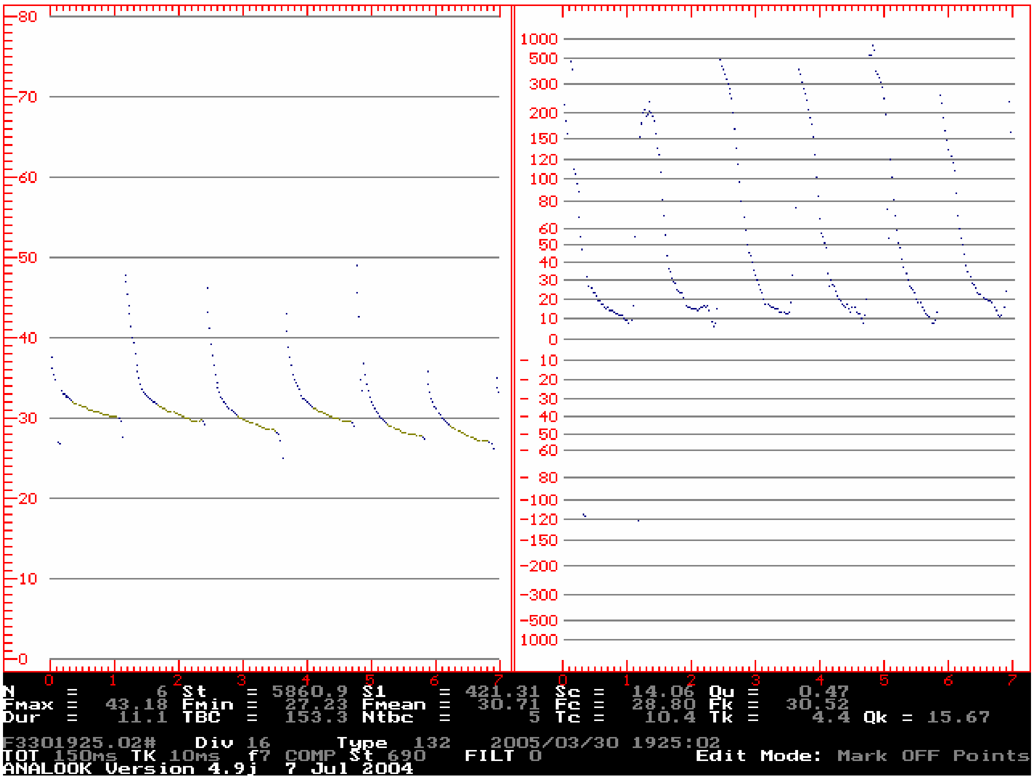
Figure 9. Eastern Bent wing Bat (*Miniopterus schreibersii oceanensis)*



```
N     =     54 St   =     0.3 S1     = 330.50 Sc =  79.93 Qu =   0.37
Fmax  =  56.51 Fmin =   46.67 Fmean  =  48.76 Fc =  46.94 Fk =  49.56
Dur   =    2.1 TBC  =    92.5 Ntbc   =     53 Tc =    2.0 Tk =    0.6 Qk =   4.64

F3301926.32#   Div 16     Type  132   2005/03/30 1926:32
TOT 150ms TK 10ms  f7 COMP St 2     FILT 0           Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

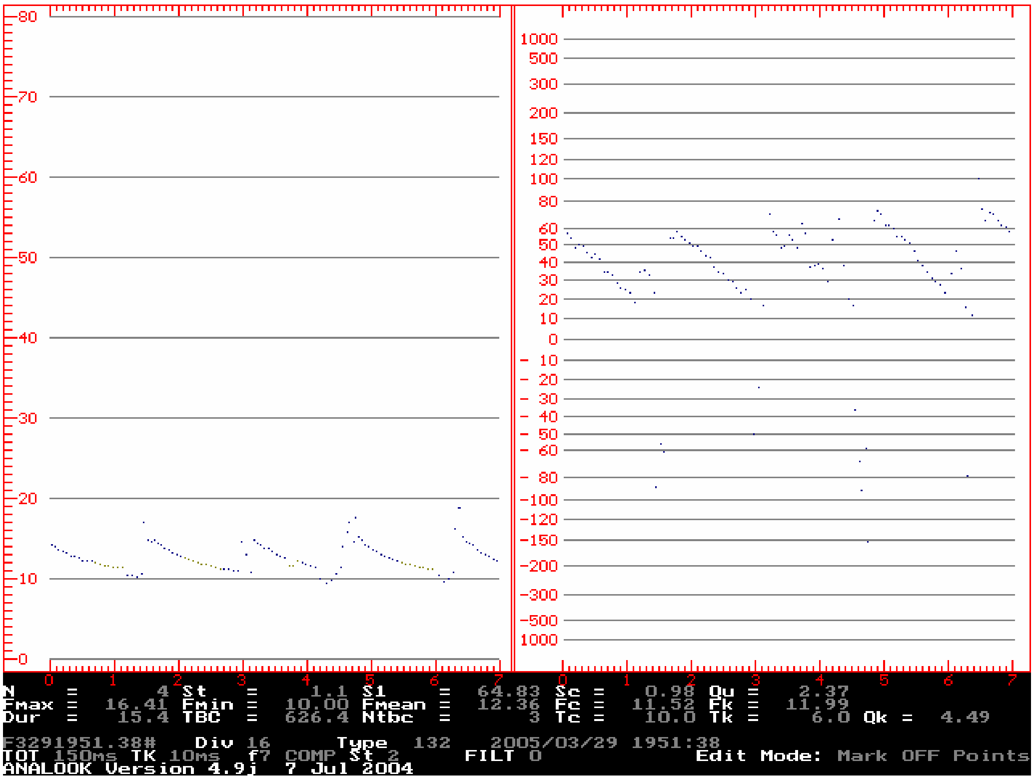
Figure 10. Eastern Bent wing Bat (*Miniopterus schreibersii oceanensis*) full call sequence.



```
N    =     6  St   = 5860.9  S1    = 421.31  Sc =  14.06  Qu =   0.47
Fmax =  43.18 Fmin =  27.23  Fmean =  30.71  Fc =  28.80  Fk =  30.52
Dur  =   11.1 TBC  =  153.3  Ntbc  =      5  Tc =   10.4  Tk =    4.4 Qk = 15.67

F3301925.02#   Div 16      Type  132    2005/03/30 1925:02
TOT 150ms TK 10ms  f7 COMP St 690    FILT 0             Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

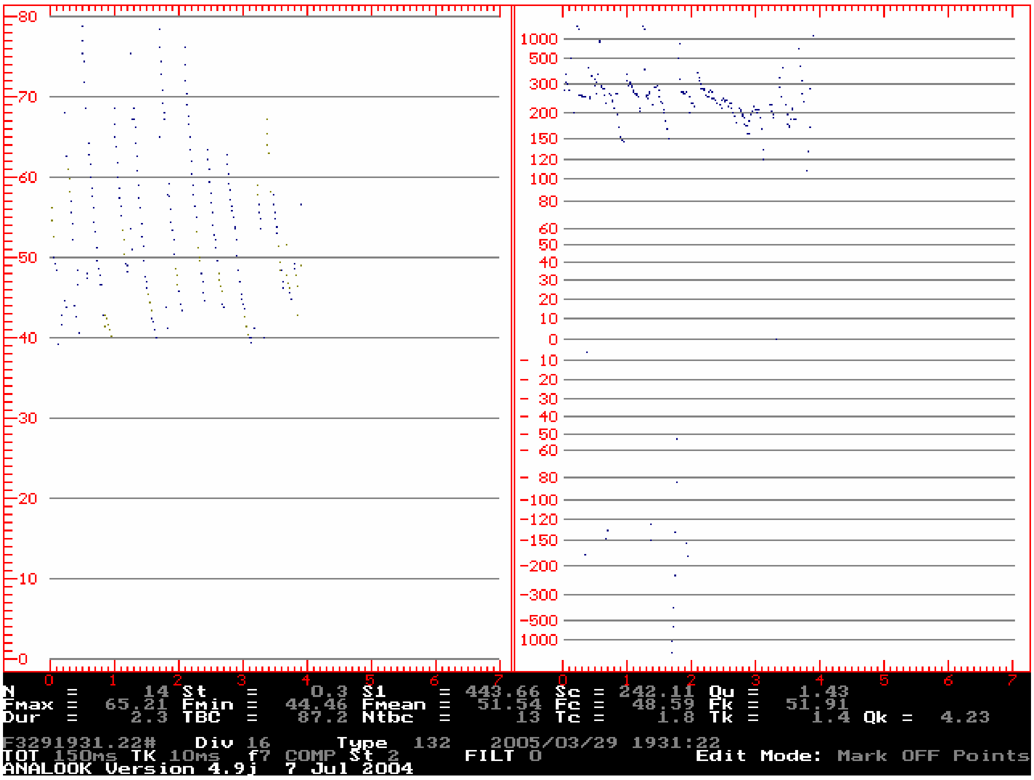
Figure 11. Gould's Wattled Bat (*Chalinolobus gouldii*)



```
N    =     4  St   =    1.1  S1    =  64.83  Sc =   0.98  Qu =   2.37
Fmax =  16.41 Fmin =  10.00  Fmean =  12.36  Fc =  11.52  Fk =  11.99
Dur  =   15.4 TBC  =  626.4  Ntbc  =      3  Tc =   10.0  Tk =    6.0 Qk =  4.49

F3291951.38#   Div 16      Type  132    2005/03/29 1951:38
TOT 150ms TK 10ms  f7 COMP St 2      FILT 0             Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

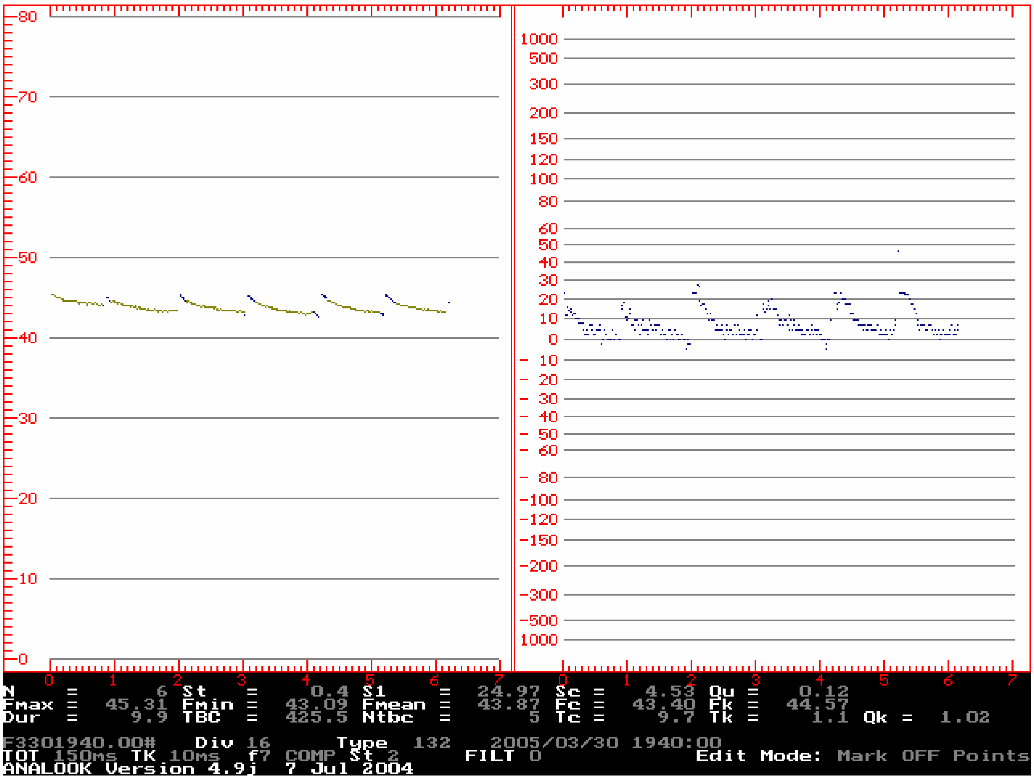
Figure 12. White-striped Freetail Bat (*Nyctinomus australis***)**



```
N     =       14 St    =      0.3 S1     = 443.66 Sc =  242.11 Qu =    1.43
Fmax  =    65.21 Fmin  =    44.46 Fmean  =  51.54 Fc =   48.59 Fk =   51.91
Dur   =      2.3 TBC   =     87.2 Ntbc   =     13 Tc =     1.8 Tk =     1.4 Qk =   4.23

F3291931.22#    Div 16      Type  132    2005/03/29 1931:22
TOT 150ms TK 10ms  f7 COMP St 2        FILT 0           Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

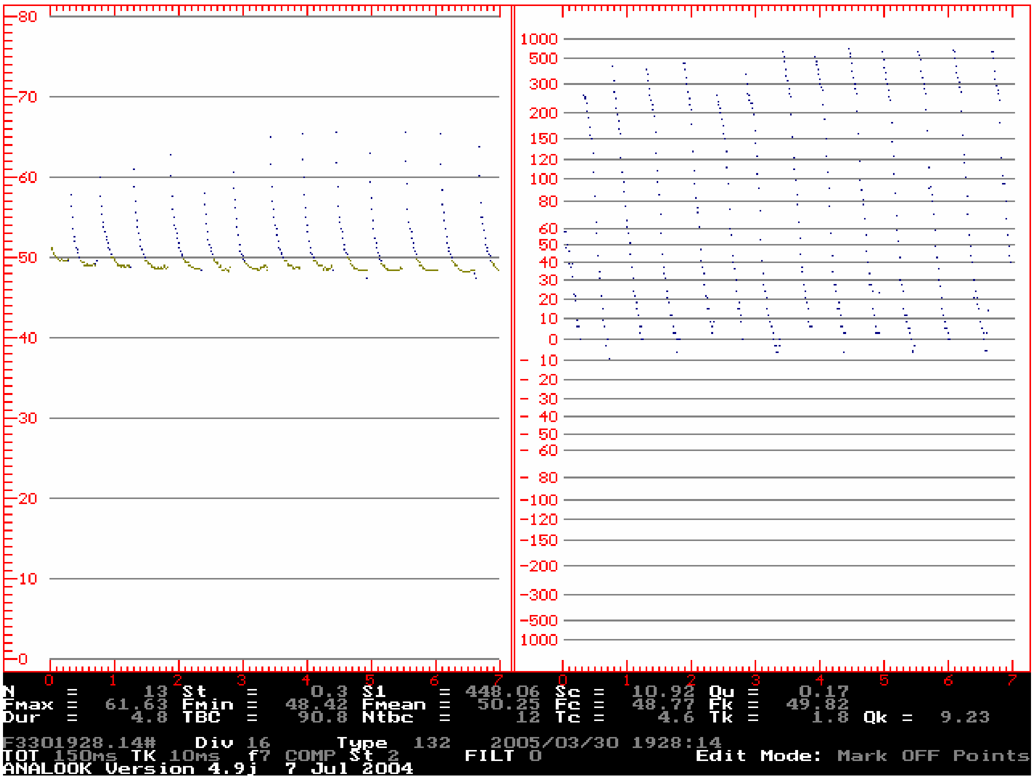
Figure 13. Long-eared Bat (*Nyctophilus spp.)*



```
N     =        6 St    =      0.4 S1     =  24.97 Sc =    4.53 Qu =    0.12
Fmax  =    45.31 Fmin  =    43.09 Fmean  =  43.87 Fc =   43.40 Fk =   44.57
Dur   =      9.9 TBC   =    425.5 Ntbc   =      5 Tc =     9.7 Tk =     1.1 Qk =   1.02

F3301940.00#    Div 16      Type  132    2005/03/30 1940:00
TOT 150ms TK 10ms  f7 COMP St 2        FILT 0           Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

Figure 14. Large Forest Bat (*Vespadelus darlingtoni)*



```
N    =      13 St    =     0.3 S1     = 448.06 Sc =  10.92 Qu =   0.17
Fmax =   61.63 Fmin  =   48.42 Fmean  =  50.25 Fc =  48.77 Fk =  49.82
Dur  =     4.8 TBC   =    90.8 Ntbc   =     12 Tc =    4.6 Tk =    1.8 Qk =   9.23

F3301928.14#    Div 16      Type  132    2005/03/30 1928:14
TOT 150ms TK 10ms   f7 COMP St 2       FILT 0          Edit Mode: Mark OFF Points
ANALOOK Version 4.9j  7 Jul 2004
```

Figure 15. Little Forest Bat (*Vespadelus vulturnus)*

Appendix F. Birds Australia Records – Gara TSR north of Waterfall Way

Table 20. List of birds recorded historically in the Gara TSR (Birds Australia Records)

Species	Recorded in the landfill study area
Australian Magpie *Gymnorhina tibicen*	Yes
Australian Raven *Corvus coronoides*	Yes
Australian Wood Duck *Chenonetta jubata*	Yes
Black Swan *Cygnus atratus*	No
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	Yes
Brown Falcon *Falco berigora*	Yes
Brown Goshawk *Accipiter fasciatus*	Yes
Brown Honeyeater *Lichmera indistincta*	No
Brown Thornbill *Acanthiza pusilla*	No
Brown-headed Honeyeater *Melithreptus brevirostris*	Yes
Brush Cuckoo *Cacomantis variolosus*	Yes
Buff-rumped Thornbill *Acanthiza reguloides*	Yes
Clamorous Reed-Warbler *Acrocephalus stentoreus*	No
Crested Shrike-tit *Falcunculus frontatus*	Yes
Crimson Rosella *Platycercus elegans*	Yes
Diamond Firetail *Stagonopleura guttata*	Yes
Dollarbird *Eurystomus orientalis*	No
Double-barred Finch *Taeniopygia bichenovii*	No
Dusky Moorhen *Gallinula tenebrosa*	No
Dusky Woodswallow *Artamus cyanopterus*	Yes
Eastern Rosella *Platycercus eximius*	Yes
Eastern Spinebill *Acanthorhynchus tenuirostris*	Yes
Eastern Yellow Robin *Eopsaltria australis*	No
Eurasian Coot *Fulica atra*	No
Fairy Martin *Hirundo ariel*	No
Fan-tailed Cuckoo *Cacomantis flabelliformis*	Yes
Forest Raven *Corvus tasmanicus*	Yes
Fuscous Honeyeater *Lichenostomus fuscus*	Yes
Galah *Cacatua roseicapilla*	Yes
Golden Whistler *Pachycephala pectoralis*	Yes
Grey Butcherbird *Cracticus torquatus*	Yes
Grey Fantail *Rhipidura fuliginosa*	Yes
Grey Shrike-thrush *Colluricincla harmonica*	Yes
Grey Teal *Anas gracilis*	Yes
Hardhead *Aythya australis*	No
Hooded Robin *Melanodryas cucullata*	No
Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*	No
Jacky Winter *Microeca fascinans*	Yes
Laughing Kookaburra *Dacelo novaeguineae*	Yes
Leaden Flycatcher *Myiagra rubecula*	Yes

Little Black Cormorant *Phalacrocorax sulcirostris*	No
Little Eagle *Hieraaetus morphnoides*	Yes
Little Lorikeet *Glossopsitta pusilla*	No
Little Pied Cormorant *Phalacrocorax melanoleucos*	No
Magpie-lark *Grallina cyanoleuca*	Yes
Mistletoebird *Dicaeum hirundinaceum*	Yes
Nankeen Kestrel *Falco cenchroides*	No
Noisy Friarbird *Philemon corniculatus*	Yes
Noisy Miner *Manorina melanocephala*	Yes
Olive-backed Oriole *Oriolus sagittatus*	Yes
Pacific Black Duck *Anas superciliosa*	Yes
Pallid Cuckoo *Cuculus pallidus*	Yes
Pied Currawong *Strepera graculina*	Yes
Plum-headed Finch *Neochmia modesta*	No
Purple Swamphen *Porphyrio porphyrio*	No
Red Wattlebird *Anthochaera carunculata*	Yes
Red-browed Finch *Neochmia temporalis*	No
Red-capped Robin *Petroica goodenovii*	No
Restless Flycatcher *Myiagra inquieta*	Yes
Rufous Songlark *Cincloramphus mathewsi*	No
Rufous Whistler *Pachycephala rufiventris*	Yes
Sacred Kingfisher *Todiramphus sanctus*	Yes
Scarlet Robin *Petroica multicolor*	Yes
Shining Bronze-Cuckoo *Chrysococcyx lucidus*	Yes
Silvereye *Zosterops lateralis*	No
Speckled Warbler *Pyrrolaemus sagittata*	Yes
Spotted Pardalote *Pardalotus punctatus*	Yes
Striated Pardalote *Pardalotus striatus*	Yes
Striated Thornbill *Acanthiza lineata*	Yes
Superb Fairy-wren *Malurus cyaneus*	Yes
Swamp Harrier *Circus approximans*	No
Torresian Crow *Corvus orru*	Yes
Varied Sittella *Daphoenositta chrysoptera*	Yes
Wedge-tailed Eagle *Aquila audax*	Yes
Weebill *Smicrornis brevirostris*	Yes
Welcome Swallow *Hirundo neoxena*	Yes
Whistling Kite *Haliastur sphenurus*	No
White-bellied Sea-Eagle *Haliaeetus leucogaster*	No
White-breasted Woodswallow *Artamus leucorynchus*	No
White-browed Scrubwren *Sericornis frontalis*	No
White-eared Honeyeater *Lichenostomus leucotis*	No
White-faced Heron *Egretta novaehollandiae*	No
White-naped Honeyeater *Melithreptus lunatus*	Yes
White-throated Gerygone *Gerygone olivacea*	Yes

White-throated Treecreeper *Cormobates leucophaeus*	Yes
White-winged Chough *Corcorax melanoramphos*	Yes
White-winged Triller *Lalage sueurii*	Yes
Willie Wagtail *Rhipidura leucophrys*	Yes
Yellow-faced Honeyeater *Lichenostomus chrysops*	Yes
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	Yes

Appendix G. Atlas of NSW Wildlife Records within a 20 km radius of the Study Area

Your selection: Flora, threatened species, Selected Area - 151.57315,-30.73704,151.99463,-30.37228 returned a total of 98 records of 11 species.

Report generated on 05/12/08 - 18:00 (Data valid to 23/11/2008)

** Exotic (non-native) species*

Plants	Map	Scientific Name	Common Name	Legal Status	Count	Info
Asteraceae						
		Picris evae	Hawkweed	V	1	
Brassicaceae						
	☐	Lepidium hyssopifolium	Aromatic Peppercress	E1	2	
Euphorbiaceae						
	☐	Bertya ingramii	Narrow-leaved Bertya	E1	17	
Haloragaceae						
	☐	Haloragis exalata subsp. velutina	Tall Velvet Sea-berry	V	2	
Myrtaceae						
	☐	Eucalyptus magnificata	Northern Blue Box	E1	15	
	☐	Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	34	
	☐	Eucalyptus rubida subsp. barbigerorum	Blackbutt Candlebark	V	2	
Poaceae						
	☐	Dichanthium setosum	Bluegrass	V	9	
Proteaceae						
	☐	Grevillea beadleana	Beadle's Grevillea	E1	6	
	☐	Hakea fraseri	Gorge Hakea	V	7	
Santalaceae						
	☐	Thesium australe	Austral Toadflax	V	3	

Your selection: Fauna, threatened species, Selected Area - 151.57315,-30.73704,151.99463,-30.37228 returned a total of 722 records of 28 species.

Report generated on 05/12/08 - 18:02 (Data valid to 23/11/2008)

** Exotic (non-native) species*

Amphibia	Map	Scientific Name	Common Name	Legal Status	Count	Info
Hylidae						

	☐	Litoria castanea	Yellow-spotted Tree frog	E1	1	
	☐	Litoria piperata	Peppered Frog	V	1	

Aves	Map	Scientific Name	Common Name	Legal Status	Count	Info
Acanthizidae						
	☐	Pyrrholaemus saggitatus	Speckled Warbler	V	160	
Accipitridae						
	☐	Lophoictinia isura	Square-tailed Kite	V	7	
Cacatuidae						
	☐	Calyptorhynchus lathami	Glossy Black-Cockatoo	V	1	
Ciconiidae						
	☐	Ephippiorhynchus asiaticus	Black-necked Stork	E1	2	
Climacteridae						
	☐	Climacteris picumnus	Brown Treecreeper	V	148	
Estrildidae						
	☐	Stagonopleura guttata	Diamond Firetail	V	85	
Meliphagidae						
	☐	Grantiella picta	Painted Honeyeater	V	4	
	☐	Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	2	
	☐	Xanthomyza phrygia	Regent Honeyeater	E1	6	
Petroicidae						
	☐	Melanodryas cucullata	Hooded Robin	V	14	
Psittacidae						
	☐	Lathamus discolor	Swift Parrot	E1	1	
	☐	Neophema pulchella	Turquoise Parrot	V	1	
Strigidae						
	☐	Ninox connivens	Barking Owl	V	5	
	☐	Ninox strenua	Powerful Owl	V	1	
Tytonidae						
	☐	Tyto novaehollandiae	Masked Owl	V	25	

Mammalia	Map	Scientific Name	Common Name	Legal Status	Count	Info

Dasyuridae					
	☐	Dasyurus maculatus	Spotted-tailed Quoll	V	146
Emballonuridae					
	☐	Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	1
Macropodidae					
	☐	Petrogale penicillata	Brush-tailed Rock-wallaby	E1	46
Petauridae					
	☐	Petaurus norfolcensis	Squirrel Glider	V	1
Phascolarctidae					
	☐	Phascolarctos cinereus	Koala	V	50
Potoroidae					
	☐	Aepyprymnus rufescens	Rufous Bettong	V	1
Vespertilionidae					
	☐	Chalinolobus nigrogriseus	Hoary Wattled Bat	V	2
	☐	Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	2
	☐	Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	5
	☐	Myotis adversus	Large-footed Myotis	V	1
	☐	Scoteanax rueppellii	Greater Broad-nosed Bat	V	3

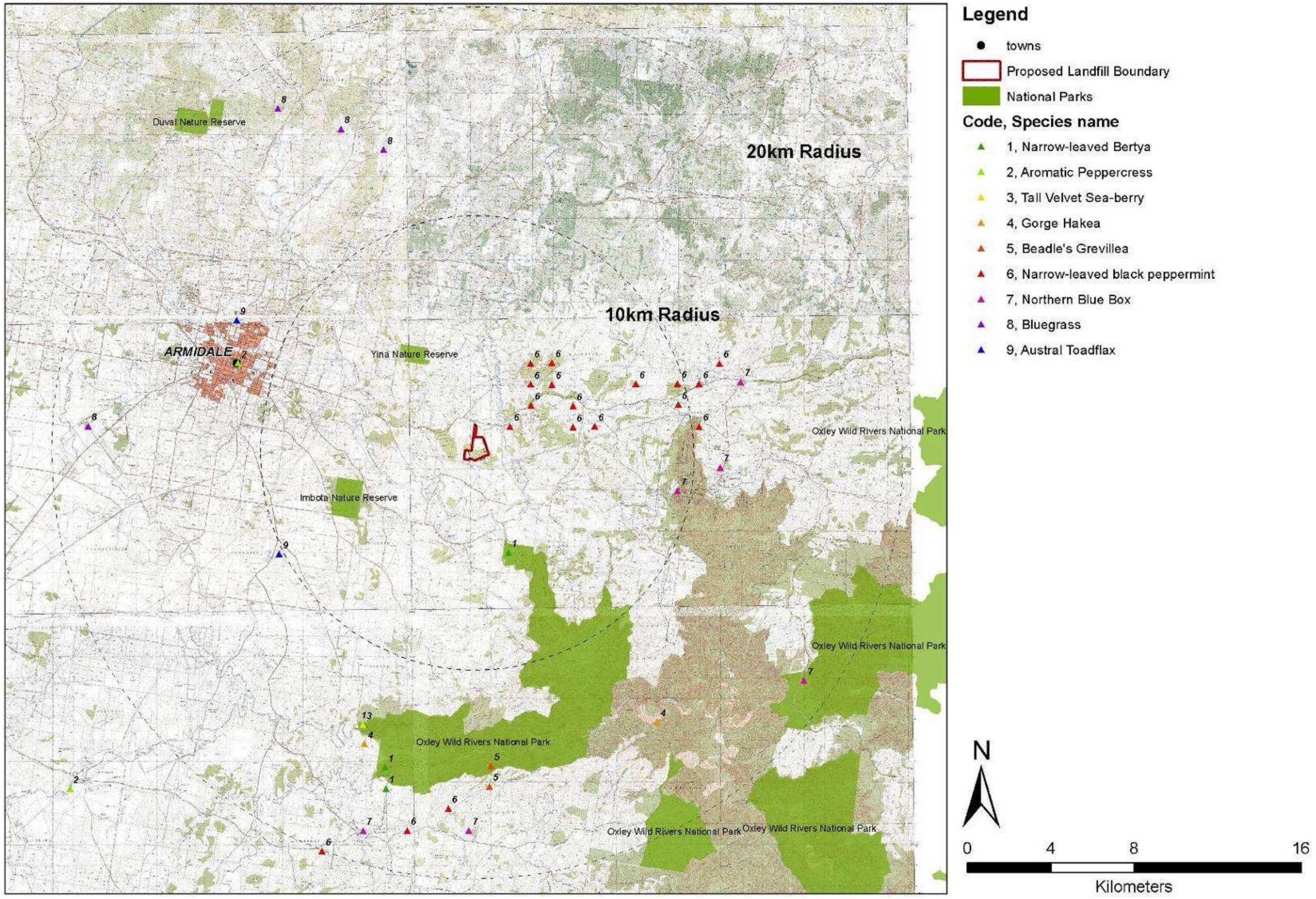


Figure 16. NPWS Wildlife Atlas –Threatened Flora recorded within 20 km of study site

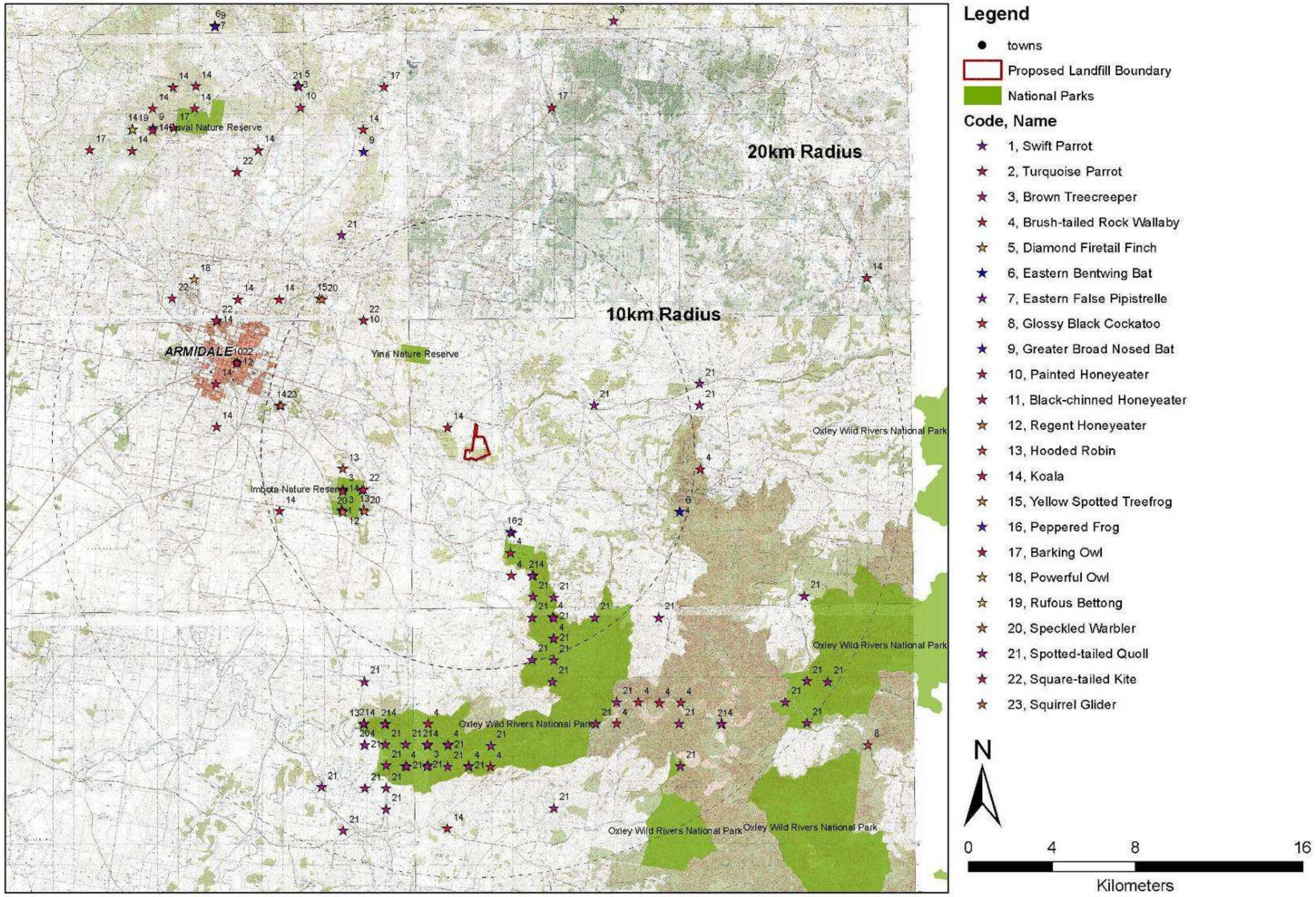


Figure 17. NPWS Wildlife Atlas –Threatened Fauna recorded within 20 km of study site

Appendix H. EPBC Protected Matters Search with a 20 km radius of the Study Area

EPBC Act Protected Matters Report 5 December 2008 17:50

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.
You may wish to print this report for reference before moving to other pages or websites.
The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at
http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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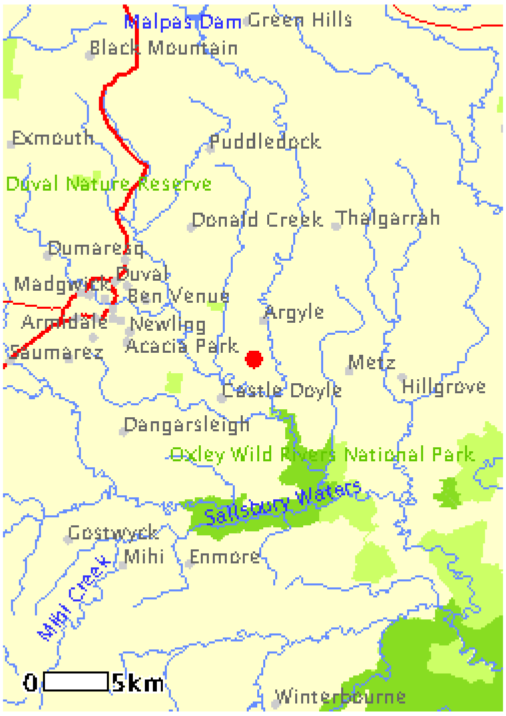

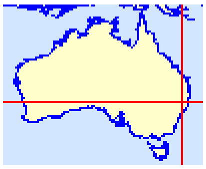

This map may contain data which are © Commonwealth of Australia (Geoscience Australia) © 2007 MapData Sciences Pty Ltd, PSMA

Search Type:	Point
Buffer:	20 km
Coordinates:	-30.55498,151.784
Report Contents:	Summary Details • Matters of NES • Other matters protected by the EPBC Act •Extra Information Caveat Acknowledgments

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Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None

Threatened Ecological Communities:	2
Threatened Species:	27
Migratory Species:	15

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps. A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	4
Commonwealth Heritage Places:	1
Places on the RNE:	26
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	3
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]

Gondwana Rainforests of Australia NSW

National Heritage Places [Dataset Information]

Gondwana Rainforests of Australia NSW

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Upland Wetlands of the New England Tablelands and the Monaro Plateau	Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Lathamus discolor Swift Parrot	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Xanthomyza phrygia Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Frogs		
Litoria booroolongensis Booroolong Frog	Endangered	Species or species habitat may occur within area
Litoria castanea Yellow-spotted Tree Frog, Yellow-spotted Bell Frog	Endangered	Species or species habitat likely to occur within area
Litoria piperata Peppered Tree Frog	Vulnerable	Species or species habitat likely to occur within area
Mixophyes iteratus Southern Barred Frog, Giant Barred Frog	Endangered	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat may occur within area
Petrogale penicillata Brush-tailed Rock-wallaby	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pseudomys oralis Hastings River Mouse	Endangered	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-Fox	Vulnerable	Species or species habitat may occur within area
Reptiles		

Underwoodisaurus sphyrurus Border Thick-tailed Gecko	Vulnerable	Species or species habitat likely to occur within area
Plants		
Bertya ingramii a shrub	Endangered	Species or species habitat likely to occur within area
Bothriochloa biloba Lobed Blue-grass	Vulnerable	Species or species habitat likely to occur within area
Callistemon pungens	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid	Vulnerable	Species or species habitat may occur within area
Dichanthium setosum	Vulnerable	Species or species habitat likely to occur within area
Diuris pedunculata Small Snake Orchid, Two-leaved Golden Moths, Golden Moths, Cowslip Orchid, Snake Orchid	Endangered	Species or species habitat likely to occur within area
Eucalyptus nicholii Narrow-leaved Peppermint, Narrow-leaved Black Peppermint	Vulnerable	Species or species habitat likely to occur within area
Grevillea beadleana Beadle's Grevillea	Endangered	Species or species habitat likely to occur within area
Hakea fraseri Gnarled Corkbark, Fraser's Hakea	Vulnerable	Species or species habitat likely to occur within area
Haloragis exalata subsp. velutina	Vulnerable	Species or species habitat likely to occur within area
Picris evae Hawkweed	Vulnerable	Species or species habitat likely to occur within area
Pultenaea campbellii New England Bush-pea	Vulnerable	Species or species habitat likely to occur within area
Thesium australe Austral Toadflax, Toadflax	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Migratory	Breeding likely to occur within area
Myiagra cyanoleuca	Migratory	Breeding likely to occur within area

Satin Flycatcher		
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Xanthomyza phrygia Regent Honeyeater	Migratory	Species or species habitat likely to occur within area

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine	Species or species habitat may occur within area

	area	
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Listed - overfly marine area	Breeding likely to occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Commonwealth Lands [Dataset Information]

Communications, Information Technology and the Arts - Australian Postal Corporation

Communications, Information Technology and the Arts - Telstra Corporation Limited

Defence - Defence Housing Authority

Unknown

Commonwealth Heritage Places [Dataset Information]

Hunter River Lancers Training Depot NSW

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

AMP Building NSW

Anglican Cathedral Church of St Peter Apostle and Martyr NSW

Armidale (C of E) School for Boys Chapel NSW

Armidale (C of E) School for Boys NSW

Armidale Conservation Area NSW

Armidale Courthouse NSW

Armidale Literary Institute (former) NSW

Armidale Post Office NSW

Armidale Town Hall NSW

Booloominbah NSW

Catholic Cathedral Church of St Mary and St Joseph NSW

Classroom, Library, Dormitory And Headmasters Residence NSW

Commercial Bank of Australia (former) NSW

Hunter River Lancers Training Depot NSW

Imperial Hotel NSW

Lands Board Office NSW

Palmerston, including Stables and Grounds NSW

Roseneath, including Outbuildings and Grounds NSW

Rural Bank (former), Banking Chambers and Managers Residence NSW

Sheriffs Cottage (former) NSW

Teachers College (former) NSW

Trevenna NSW

Uloola Garden NSW

Westpac Bank NSW

Natural

Arthurs Seat - Bald Nobs Geological Site NSW

Megacryst Bearing Lava Site NSW

Extra Information

State and Territory Reserves [Dataset Information]

Imbota Nature Reserve, NSW

Oxley Wild Rivers National Park, NSW

Yina Nature Reserve, NSW

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

Lower North East NSW RFA, New South Wales

Appendix I. TSC Act – Box Gum Woodland EEC Identification

Identification of Box Gum Woodland (NPWS 2002b)

The Overstorey

The EEC Box Gum Woodland is identified by having an overstorey dominanted White Box, Yellow Box and/or Blakely's Red Gum tress. The density of trees is not relevant to the existence of the EEC. The Final Determination specifically includes treeless areas in the EEC "*as a result of past clearing or thinning.*"

The Understorey

Box Gum Woodland includes vegetation where "*Grass and herbaceous species generally characterise the ground layer. Shrubs are generally sparse or absent, though they may be locally common.*" The term "*locally common*" is not defined, but the intent of the statement is that shrubs may be dominant over parts of an EEC site. Shrub species are recognised as important constituents of the community if 27 of the 95 characteristic species listed in the Final Determination are shrubs. However, shrubby woodlands, which generally occur in upper or midslope situations on shallower soils, are not part of the EEC. Such woodlands are more prevalent on hillsides of the North Western Slopes (Nandewar and Brigalow Belt South Bioregions).

In some cases, the shrub layer is primarily *Acacia* spp. or *Cassinia* spp., which are characteristically pioneer colonising species that invade sites after disturbance such as clearing, overgrazing or fires. These species generally only live 10-15 years and are replaced with a predominantly grassy understorey. These areas are regarded as Box Gum Woodland. In most locations the understorey will vary considerably depending on the season, management history and rainfall in preceding months. Care in assessing a site is required when a flush of annual exotic species obscures native perennial species. Reassessment of the site after the annuals have died is desirable. Ideally sites should be assessed in both spring and in autumn so that seasonal native species such as orchids, lilies and native annuals can be identified.

Degraded Sites

The definition of the Box Gum Woodland explicitly recognises that some remnants are degraded. Highly disturbed sites that have few if any native species in the understorey are specifically included in the community provided "*vegetation, either understorey or overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.*" In some parts of NSW Box Gum Woodlands are only represented by isolated paddock trees with a highly modified understorey. Such remnants or vestiges of the community may still constitute valuable fauna habitat in agricultural areas and may provide a valuable source of seed for potential future regeneration.

Assisted Natural Regeneration

Determining whether the vegetation will respond to assisted natural regeneration will often be highly problematic. Sites where there is unlikely to be sufficient seed remaining in the soil for the understorey or overstorey to regenerate are not part of the EEC. For example, trees under which intensive cropping of annual crop species has occurred and is ongoing, and trees within urban backyards, are unlikely to be part of the community. Conversely, trees with exotic pastures underneath and those in larger urban open spaces will generally be part of the community.

Inevitably difficulties will arise when faced with decisions on whether particular sites are able to respond to assisted natural regeneration. Expert advice may need to be sought in these circumstances. One of the recovery actions for this community is the further investigation of the regeneration potential of various conditions of this EEC in a range of environmental situations.

Identifying the EEC, Box Gum Woodland (TSC Act)

The key shown below provides a guide for use in determining whether the EEC, Box Gum Woodland occurs on a patch of land (NPWS 2002):

1 The site is in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands or NSW South Western Slopes Bioregions:
2
1* The site is outside the above bioregions:
the site is not Box Gum Woodland

2 There are no native species in the understorey, and the site is unlikely to respond to assisted natural regeneration (see section on Degraded Sites, above):
the site is not Box Gum Woodland
2* The understorey is otherwise:
3

3 The site has trees:
4
3*The site is treeless, but is likely to have supported White Box, Yellow Box or Blakely’s Red Gum prior to clearing:
5

4 White Box, Yellow Box or Blakely’s Red Gum, or a combination of these species, are or were present:
5
4* White Box, Yellow Box or Blakely’s Red Gum have never been present:
the site is not Box Gum Woodland

5 The site is predominantly grassy:
the site is Box Gum Woodland
5* The understorey of the site is dominated by shrubs excluding pioneer species (see section on The Understorey: above):
the site is not Box Gum Woodland

TSC listed Endangered Ecological Communities on the subject site

White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland) listed under the TSC Act

The open woodland located in the TSR appears to be a Box Gum Woodland. The following steps have been followed in the key set out in the NPWS identification guidelines (NPWS 2002) for use in determining whether the EEC Box Gum Woodland exists on a site.

Assessment of the open woodland in the TSR:

1 The patch of open woodland is in the New England Tablelands Bioregion

2 There are native species in the understorey, and the open woodland is likely to respond to assisted natural regeneration, given the number of mature Yellow Box and Blakely's Red Gum.

3 The patch of open woodland has trees.

4 Yellow box and Blakely's Red Gum are present.

5 The patch of open woodland is predominantly grassy.

The woodland in the TSR is included in the EEC Box Gum Woodland.

Assessment of the cleared grassland on the northern portion of the site adjacent to the TSR:

1 The grassland is in the New England Tablelands Bioregion.

2 There are native species in the understorey and the cleared grassland is likely to respond to assisted natural regeneration (see comments on assisted natural regeneration above);

3 The site is treeless, but is likely to have supported Yellow Box &/or Blakely's Red Gum prior to clearing.

4. Yellow box and Blakely's Red gum were likely to have been present in the past.

5 The site is predominantly grassy.

The mostly cleared grassland adjacent to the TSR is included in the EEC Box Gum Woodland.

Assessment of the stringbark woodland:

1. The woodland is in the New England Tablelands Bioregion.

2 There understorey is heavily degraded and is unlikely to respond to assisted natural regeneration;

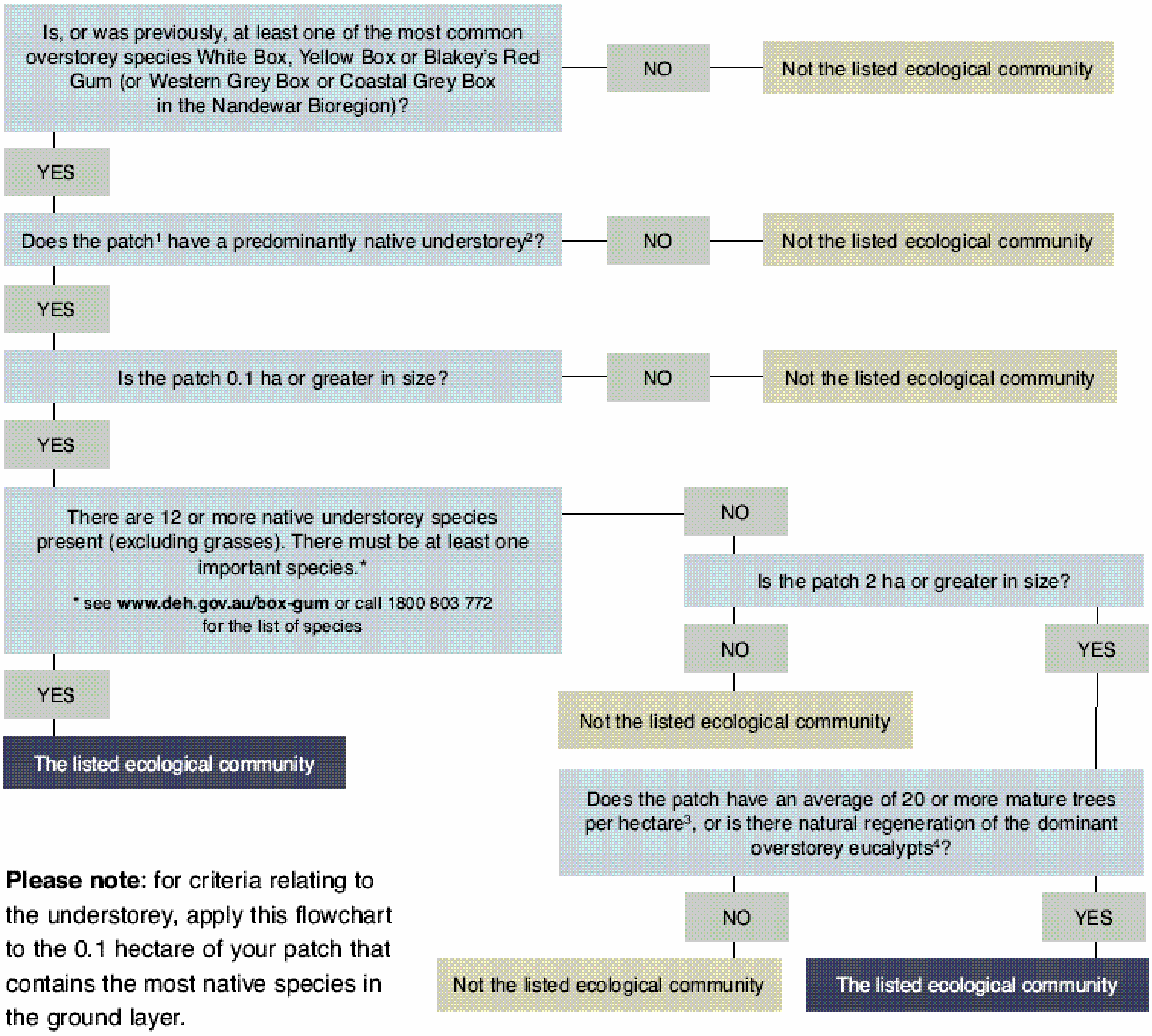
3 The site has trees, but is dominated by New England Stringybark (*Eucalyptus caliginosa*).

The Stringybark Woodland is not included in the EEC Box Gum Woodland.

Appendix J. EPBC Act – CE Ecological Community – Box Gum Woodland

The flowchart below represents the lowest condition at which patches are included in the listed ecological community. This is not the ideal state of the ecological community. Large patches, those that link remnants in the landscape, those that occur in highly cleared areas, those that contain rare, declining or threatened species, and those that represent the entire range of the ecological community, are important for the long-term future of the ecological community.

Determining if your land has an area of the listed ecological community



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

---

[1] Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:

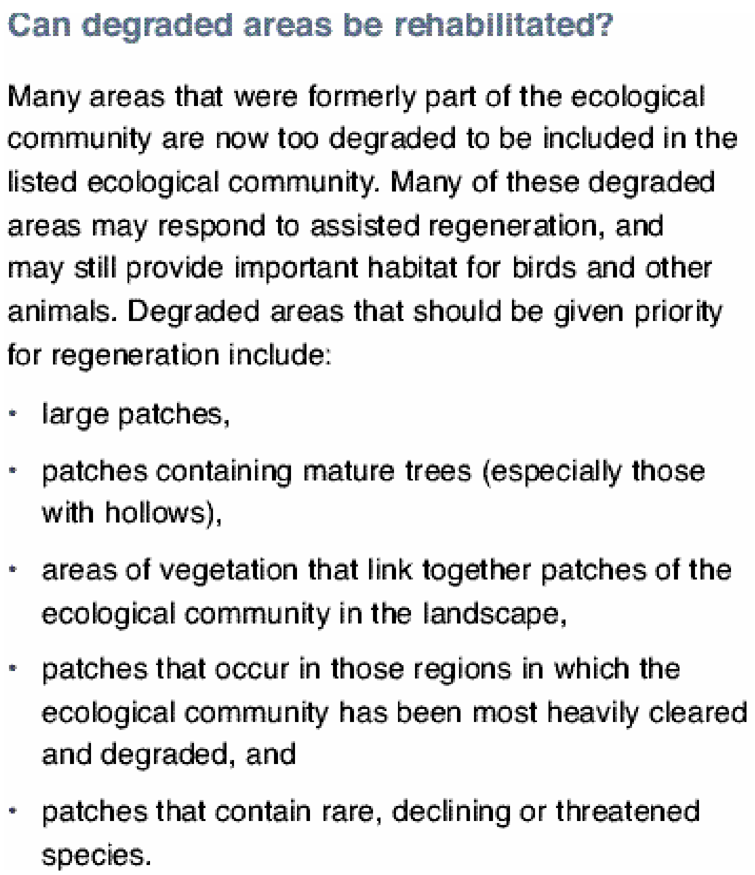
- an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
- the area over which the understorey is predominantly native.

Patches must be assessed at a scale of 0.1 ha ($1000m^2$) or greater.

[2] A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not is if it is difficult to pull out of the soil. Annual species pull out very easily.)

[3] Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.

[4] Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.



Can degraded areas be rehabilitated?

Many areas that were formerly part of the ecological community are now too degraded to be included in the listed ecological community. Many of these degraded areas may respond to assisted regeneration, and may still provide important habitat for birds and other animals. Degraded areas that should be given priority for regeneration include:

- large patches,
- patches containing mature trees (especially those with hollows),
- areas of vegetation that link together patches of the ecological community in the landscape,
- patches that occur in those regions in which the ecological community has been most heavily cleared and degraded, and
- patches that contain rare, declining or threatened species.

EPBC listed Critically Endangered Ecological Communities on the subject site

White Box Yellow Box Blakely's Red Gum Woodland and Derived Grassland (Box Gum Woodland and Derived Grassland) listed under the EPBC Act

The Commonwealth Department of the Environment and Heritage provides a flowchart for determining whether or not the EPBC-listed CE ecological community Box Gum Woodland exists on a site. The following steps from that flowchart were applied to the vegetation communities present on the site.

Assessment of the open woodland in the TSR:

1 Yellow box and Blakely's Red Gum are present.
2 At least 50% of the perennial vegetation cover is made up of native species.
3 The patch is more the 0.1 ha in size.
4 There are more than 12 native understorey species present, excluding grasses.
5 The patch is greater than 2 ha in size.
6 The patch has more than 20 mature trees .per hectare and there is natural regeneration of the Yellow Box and Blakely's Red Gum on the patch.

The woodland in the TSR is the EPBC-listed Critically Endangered Ecological Community Box Gum Woodland

Assessment of the cleared grassland on the northern portion of the site adjacent to the TSR:

1 Yellow box and Blakely's Red Gum are present.
2 At least 50% of the perennial vegetation cover is made up of native species.
3 The patch is more the 0.1 ha in size.
4 There are less than 12 native understorey species present, excluding grasses.
5 The patch is greater than 2 ha in size.
6 The patch has an average of less than 20 mature trees per hectare, and there is no natural regeneration of the Yellow Box and Blakely's Red Gum on the patch.

The cleared grassland on the site is NOT the EPBC-listed Critically Endangered Ecological Community Box Gum Woodland

Assessment of the Stringybark Woodland:

1 There is no indication that white box, **Yellow Box** and/or Blakely's Red Gum were previously the dominant tree species in the Stringybark Woodland.

.

The Stringybark Woodland in the landfill footprint area is not the EPBC-listed Critically Endangered Ecological Community Box Gum Woodland

Appendix K. Soil Landscapes of the Study Area

Table 21. Soil Landscapes of the Armidale 1:100000 Sheet Report (King in prep)

	% of Site	Landscape	Soils
Argyle	75.8	Rolling low hills and occasional hills on greywacke/chert and related sediments. Local relief 30 - 80 m, slopes mostly 10 - 30%, elevation 910 – 1170 m. Minor rock outcrop (<10%) Partially cleared Typically supports *Eucalyptus caliginosa* (New England Stringybark) open woodland.	Soil in the landscape were identified as very shallow to shallow (<50 cm), well drained Basic Lithic Leptic Rudosols (Lithosols) and other shallow soils on crests, ridges and upper slopes. Shallow to moderately deep (40- 80 cm) moderately well drained Haplic Eutrophic Yellow Kandosols/ Tenosols (Yellow Earths) on midslopes and occasionally extending onto crests. Shallow to moderately deep (<80 cm) moderately well drained Yellow/Red and Grey Chromosols (Yellow and Red Podzolic Soils) on mid slopes, footslopes and drainage lines. Mottled-Subnatric Eutrophic Brown and Yellow Sodosols (Soloths) occur along some drainage depressions.
Middle Earth	22.7	Undulating plains, rises and footslopes on Sandon Beds. Local relief 0-30 m, slopes 0-10%, elevation 910 - 1120 m. Typically extensively cleared open woodland to partially cleared.	The soils across the landscape group can be identified as moderately deep to deep (>70 cm), moderately well drained Bleached-Mottled Haplic Eutrophic Yellow Kurosols and Chromosols (Yellow Podzolic Soils) are widespread. Deep (>100 cm), poorly drained Yellow Chromosols and Mottled-Mesonatric and Mottled-Subnatric Eutrophic Yellow Sodosols (Soloths) and Bleached-Manganic and Bleached-Ferric Eutrophic Yellow Chromosols (Lateritic Podzolic Soils/ Grey Brown Podzolic Soils) occupy drainage depressions and poorly drained areas. Occasional shallow (<40 cm), well drained Bleached Eutrophic Yellow Kandosols (Yellow Earths) on slopes with bedrock close to the surface.
Commissioners Waters	1.5	Narrow streams, swamps and occasional small floodplains/terraces on Quaternary alluvium. Includes Commissioners Waters and the Gara River and tributaries. Local relief 0-10 m, slopes 0 – 3%, elevation 900 –1070 m. Typically extensively cleared open woodland.	Soils are variable according somewhat to the source rocks from which they are derived. Shallow to moderately deep (40 – 100 cm) well drained Alluvial Sands and Alluvial Loams (Yellow/ Brown and Grey Earths) occur in areas derived from coarse grained parent materials. Moderately deep to deep (>80 cm), moderately well drained Mottled Eutrophic Grey Chromosols/ Grey Sodosols (Gleyed Podzolic Soils/ Grey Brown Podzolic Soils/ Lateritic Podzolic Soils) are also fairly common.

Appendix L. Codings for ROTAP Plants

ROTAP, or Rare or Threatened Australian Plants codes (Briggs and Leigh 1996) are taken from a national list which indicates the conservation status of plants throughout the nation. The codes have three categories which give an overall view of the species population size and distribution:

Category 1 Distribution

1 Species known only from the **type locality** (i.e. where the species was first described) but nowhere else.

2 Species with a very restricted distribution in Australia and with a maximum geographic range of **less than 100 km**.

3 Species with a range **over 100 km** in Australia but occurring only in small populations which are mainly restricted to highly specific and localised habitats.

Category 2 Conservation Status

X Presumed Extinct – species that have either not been found in recent years despite thorough searching, or have not been collected for at least 50 years and were known only from now intensively settled areas.

E Endangered – species in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate.

V Vulnerable – species not presently Endangered but at risk of disappearing from the wild over a longer period (20-50 years) through continues depletion, or which largely occur on sites likely to experience changes in land use that would threaten the survival of the species in the wild.

R Rare – species which are rare in Australia but which overall are not currently considered Endangered or Vulnerable. Such species may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wider range, or some intermediate combination of distribution pattern.

K Poorly Known – species that are suspected, but not definitely known, to belong to any of the above categories. At present field distribution information is inadequate.

Category 2 Reservation and adequacy of reservation

C This symbol is used to indicate when a species is known to be represented within a national park or other proclaimed reserve.

A This indicates that the species is considered adequately reserved, with a total population of 1000 plants or more known to occur within conservation reserves.

i Indicates that the species is considered to be inadequately reserved, with a total population of less than 1000 plants known to occur within conservation reserves.

- Indicates that the species has been recorded from a reserve or reserves but that the population size within the reserves is unknown.

t Indicates a situation where the total known population of a species is within a conservation area or areas, and therefore it is not possible to further reserve the species.

For example:

Hakea pulvinifera **ROTAP Status: 3ECi**

3 This species has a wide distribution with small, restricted populations
E It is considered Endangered
C It is known to be in conservation reserves
i Reservation is inadequate to conserve the species

Tylophora linearis **ROTAP Status: 3E**

3 This species has a wide distribution with small, restricted populations
E It is considered Endangered

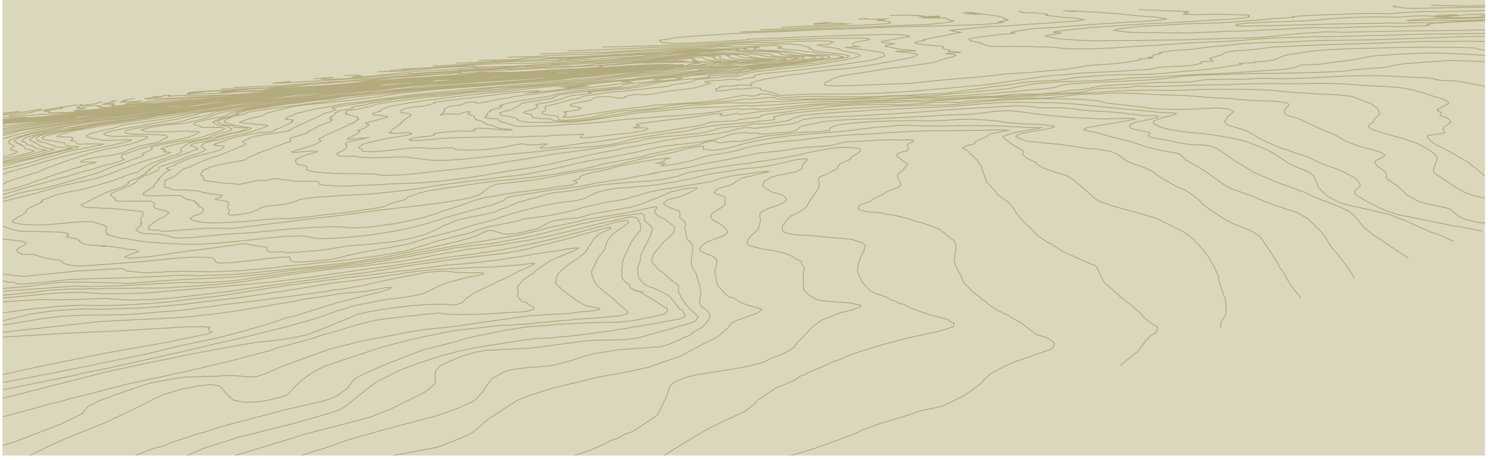
This species does not have a category 3 code (reservation and adequacy of reservation) because it has not been located within a national park or conservation reserve.

Appendix F

RCA Australia, 2007: Hydrogeological Investigation

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



HYDROGEOLOGICAL INVESTIGATION

PROPOSED ARMIDALE LANDFILL

Prepared for

MAUNSELL AUSTRALIA PTY LTD

On behalf of

Armidale Dumaresq Council

Prepared by

RCA AUSTRALIA

RCA ref 5929-004/2

August 2007

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DOCUMENT STATUS

Rev No.	Comment	Author	Reviewer	Approved for Issue (Project Manager)		
				Name	Signature	Date
/0	Draft	C Wellings	M Allman	M Allman		30.05.07
/1	Final	C Wellings	M Allman / F Robinson	M Allman		25.07.07
/2	Final	C Wellings	M Allman/ F Robinson	M Allman		10.08.07

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/0	1	Electronic	RCA – Job Archive	30.05.07
/1	2	Bound report	Maunsell Australia Pty Ltd - Jamon Pool	25.07.07
/1	1	Electronic (CD)	Maunsell Australia Pty Ltd - Jamon Pool	25.07.07
/1	1	Electronic	RCA – Job Archive	25.07.07
/1	1	Bound Report	RCA – Job Archive	25.07.07
/2	2	Bound Report	Maunsell Australia Pty Ltd - Jamon Pool	10.08.07
/2	1	Electronic (CD)	Maunsell Australia Pty Ltd - Jamon Pool	10.08.07
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RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

Geotechnical Engineering
Engineering Geology
Environmental Engineering
Hydrogeology
Construction Materials Testing

RCA ref 5929-004/2
Client ref 20019706.00

10 August 2007

Armidale-Dumaresq Council
c/- Maunsell Australia Pty Ltd
PO Box Q410
QVB Post Office
SYDNEY NSW 1230

Attention: Mr Jamon Pool

HYDROGEOLOGICAL INVESTIGATION
PROPOSED ARMIDALE LANDFILL

1 INTRODUCTION

This report describes a hydrogeological investigation carried out for Maunsell Australia Pty Ltd on behalf of Armidale-Dumaresq Council at the site of the proposed Armidale landfill.

The work was commissioned by Mr Jamon Pool of Maunsell Australia Pty Ltd in March, 2007.

The proposed landfill is situated approximately 12 km east of Armidale, off the Waterfall Way. The site location is indicated on the location plan and included on Drawing 1, Appendix A.

The proposed site features and the data provided have previously been detailed in the RCA report 5929-002/1, Geotechnical and Hydrogeological Investigation, Proposed Armidale Landfill, January, 2007 (Ref [1]).

This report contains descriptions of the surface and subsurface conditions at the site and provides discussion on:

- hydrogeological conditions across the site; and
- groundwater level and quality.

The factual data on which this report is based is presented in the attached appendices.

Data from previous reports listed above is cross-referenced where relevant.

The report has been prepared for the purpose of providing additional baseline hydrogeological data, to that provided in the January, 2007 report (Ref [1]), to allow detailed design of the proposed landfill facility to progress and to plan for subsequent ongoing groundwater monitoring of the proposed facility.

2 FIELD AND LABORATORY INVESTIGATIONS

Fieldwork was undertaken over the period 16 to 20 April, 2007 and consisted of the following:

- Drilling of seven (7) bores (two abandoned) to depths ranging from 22m (BH13) to 60m (BH9):
  - The two abandoned bores were both attempts to drill BH9, in both cases confining pressure was lost due to a subsurface void, possibly a fault in the rock structure, and the drilling could not continue at that location:
    - Location 1 reached a depth of 41m;
    - Location 2 reached a depth of 33m;
    - Groundwater was not encountered in either location;
- Groundwater monitoring wells were installed in five (5) bedrock bores (BH9 - 13).
- All newly installed groundwater monitoring wells were developed and allowed to stablise prior to sampling to ensure that all samples collected were representative of the groundwater conditions at each location.
- Permeability tests were conducted in two (2) monitoring wells (BH5 and BH11).
- Groundwater samples were collected from a total of seven (7) wells comprising the existing wells BH4 and BH5 and the newly installed wells (BH9 – 13).

All fieldwork was carried out by and in the presence of RCA personnel. Test locations are shown on the attached site plan (Drawing 1, Appendix A).

Bore locations were specified by Maunsell Australia Pty Ltd and were located in the field by hand held GPS unit. Subsequent to testing, the locations were surveyed by Hawkins Hook Surveyors.

Engineering logs of bores are presented in Appendix B, together with explanation sheets. Groundwater conditions have been noted on the bore logs at the time of fieldwork. Fluctuations in groundwater conditions may be expected due to variations in site conditions and rainfall. Groundwater levels were measured with a dip meter.

Water samples were obtained from the groundwater monitoring bores for the purpose of water quality testing. Seven (7) water samples (BH4, BH5, BH9 – 13) were collected using a specialised Bennett deep sampling pump. Samples were collected after purging indicated that water quality parameters (pH, conductivity, salinity, dissolved oxygen, turbidity and temperature) had stabilised by monitoring with a Horiba water quality meter. The values at the time of sampling have been recorded on the groundwater sampling sheets, Appendix G.

3 SITE DESCRIPTION

The regional geology, surface and subsurface conditions of the site have been discussed in detail in RCA report 5929-002/1 (Ref [1]) which should be read in conjunction with any findings or recommendations made in this report.

4 ASSESSMENT CRITERIA

4.1 LABORATORY ANALYSIS

Australian Laboratory Services (ALS) was chosen as the primary laboratory. This laboratory is NATA accredited and is experienced in the analytical requirements for testing groundwater.

ALS undertook internal quality assurance testing. Results are contained within the laboratory report sheets, Appendix D. A review of the results shows that sufficient internal QA sampling was undertaken by ALS. The results for all internal laboratory duplicates, laboratory control samples, method blanks and matrix spikes met the acceptance criteria as detailed on the ALS Quality Control Report, ES0705128, attached in Appendix C, except for the matrix spike recovery for the halogenated aliphatic compound 1, 1-dicloroethene. The recovery for the matrix spike for this compound was outside the acceptance criteria by less than 1%. Therefore any uncertainty associated with the reported results for this compound is not considered significant.

A matrix spike is an internal laboratory sample which is 'spiked' with a known concentration of a contaminant. The sample is then analysed and the recovery reported. The purpose of the spike is to determine whether the sample is strongly adsorbing the contaminant and preventing complete extraction which reduces the accuracy of the analysis.

4.2 ACCEPTANCE CRITERIA – GROUNDWATER

4.2.1 NSW DEC GROUNDWATER GUIDELINES 2007

The 2007 Groundwater Guidelines (Ref [2]) require that groundwater contaminant concentrations be compared to existing generic groundwater investigation levels (GIL's). The guidelines cite the following documents as appropriate sources of GIL's for contaminant assessment of groundwater:

- drinking water - NHNRC and NRMMC 2004 (Ref [3]); and
- Aquatic Ecosystems - ANZECC & ARMCANZ 2000a (Ref [4]).

For the protection of aquatic ecosystems, the GIL for 95% protection (ANZECC 2000a) should be used. Where the existing generic GIL is below the naturally occurring background concentration of a particular contaminant, the background concentration becomes the default.

Where the existing generic GIL for a particular contaminant is below the practical limit of reporting or below the detection limit, the quantitative limit of reporting or the detection limit should be used instead of the existing generic GIL.

Where a generic GIL does not exist for a particular contaminant or if the generic GIL's are not considered stringent enough to protect the ecology or human health, guidance from the DEC is recommended.

4.2.2 ANZECC AND ARMCANZ 2000A

These water quality guidelines have been endorsed by the NSWEPA (Ref [2]). They consider not only the level of protection (eg, 99% or 95%) but also the state of the receiving water (eg, moderately disturbed). Additional allowances are also made for the bioaccumulation of some chemicals. These guidelines replace the NEPC NEPM 1999 guidelines for water (Ref [5]). As the 2007 Groundwater Guidelines (Ref [2]) require that only the 95% level of protection is to be adopted for groundwater assessment, the state of the receiving water is not required to be classified for groundwater assessments.

4.2.3 NHNRC AND NRMMC 2004

These are the Australian Drinking Water Guidelines and have been endorsed by the NHNRC (Ref [2]). They provide guidance values for both the physical and chemical characteristics of drinking water. The guideline values provided are based on both human health and aesthetic considerations.

4.2.4 APPROPRIATENESS OF THE GUIDELINES

The endorsed NSW DEC groundwater guidelines require that the ANZECC and ARMCANZ 2000a water guidelines for the protection of aquatic ecosystems based on the protection of the receiving waters (for groundwater assessments 95% level of protection is adopted) and the NHNRC and NRMMC 2004 drinking water guidelines based on human health and aesthetic considerations be used for groundwater assessment. Therefore they are considered to be the most appropriate guidance available.

4.2.5 LIMITATIONS OF THE GUIDELINES

Regardless of the guidelines adopted for the site, any groundwater assessment is likely to be conservative when applying the ANZECC and ARMCANZ 2000a water guidelines for the protection of aquatic ecosystems. This is due to the distance the site is situated from the nearest significant receiving water body, the Gara River (approx 1km), natural attenuation processes and the relatively small area of the site when compared to the total river catchment. Therefore the concentrations detected in the site groundwater do not necessarily represent the final concentration of the contaminants potentially reaching the river.

4.3 QUALITY ASSURANCE/QUALITY CONTROL

No duplicate samples were undertaken as part of this assessment.

Two (2) holding time outliers occurred from two (2) analytes in all wells, nitrate as N and pH. These holding times could not be met due to the period between on site sampling and delivery to the laboratory based in Newcastle. The delay was predominantly due to the need to remain at the site to install and develop the five (5) additional monitoring wells. As a result, the sampling of the wells was staggered over several days. Subsequent sampling events which do not require wells to be installed should not be subject to similar delays. Holding times for nitrate analyses associated with these events would be expected to be met.

The analysis of pH outside of holding time is not considered to create a significant level of uncertainty, as the pH of the wells was also measured in the field with a calibrated pH meter. Given that the laboratory holding time for pH is between six and 24 hours, it is unlikely that samples could be transported to the laboratory and analysed within holding time even if forwarded immediately after sampling.

As a result of the nitrate analyses being out of holding time, the reported results are conservative and may overstate the concentrations. Nitrate is stable for at least twenty eight (28) days, under the appropriate preservation and handling. Nitrite is stable for only two (2) days under the same conditions. Nitrate concentrations are not directly measured by the laboratory. The method for nitrate analysis involves analysing for NOx (nitrate + nitrite), then subtracting the nitrite concentration from the NOx result to calculate the nitrate result. If the analyses are undertaken after more than two (2) days, nitrite can begin to convert to nitrate, increasing the nitrate result reported.

All NOx analyses were undertaken within holding times (28 days). The NOx results associated with this assessment are considered to be accurate.

5 RESULTS

Results of the groundwater analyses are attached in Appendix C. In summary:

- Three (3) results are in excess of the 95% Fresh water ANZECC guidelines (Ref [4]):
  - BH9 Nitrate
  - BH10 Nitrate
  - BH4 Iron
- Two (2) results are in excess of the Health based criteria of the NHNRC Drinking water Guidelines (Ref [3]):
  - BH4 Manganese
  - BH5 Manganese, Sulfate
- Six (6) results are in excess of the Aesthetic based criteria of the NHNRC Drinking Water Guidelines (Ref [3]):
  - BH4 Iron, Manganese
  - BH5 Sodium, Manganese, Ammonia, Sulfate, Chloride
  - BH9 Manganese, Chloride
  - BH10 Chloride.

Results from BH4 and BH5 have also been compared to the previous sampling round (October, 2006) in Appendix C. Generally the results were consistent between sampling rounds except for the following:

- Chloride in BH4 decreased by approximately 50%.
- Nitrate in BH4 increased significantly (over ten fold), whereas it decreased significantly in BH5 (to less than 10% of previous result). These results therefore affected the Nitrite + Nitrate calculation.
- Iron increased ten fold in BH4.
- Ammonia increased by 1.6 times in BH4 and over six times in BH5.

Other chemical indicators which were detected in the wells included:

- Chloroform;
- Total Organic Carbon; and
- Phenols.

6 FIELD TEST RESULTS

Tests for hydraulic conductivity (permeability) were undertaken at two (2) bore locations. Due to the conditions encountered and project constraints, only one (1) test was undertaken in each bore. The result and analysis sheets for these tests are attached in Appendix E. Hydraulic conductivity test results are summarised in Table 1.

Table 1 *Hydraulic Conductivity/Permeability Test Result Summary*

Bore Number	**Test Method**	**Permeability (m/s)**
BH11	Falling Head Piezometer Test (Hvorslev method)	3.8×10^{-6}
BH5 [1]	Rising Head Test (Hvorslev method)	4.4×10^{-8}

[1] The falling head test was conducted over a relatively short period and has required extrapolation to interpret the permeability.

The results indicate that the permeability of the sandstone bedrock tested in the vicinity of monitoring well, BH11 is in the order of 3.8×10^{-6}. The permeability of the argillite bedrock in the vicinity of well BH5 was in the order of 4.4×10^{-8} m/s. The permeability of the argillite bedrock tested in the vicinity of BH4 during the previous investigation (Ref [1]) was 4.8×10^{-9} m/s. This result is at odds with field observations made during the latest assessment.

Attempts were made to undertake a rising head test in the well BH11. However, due to the relatively high permeability of the strata encountered, the standing water level in the bore could not be lowered sufficiently to ensure an accurate test result. Therefore a falling head test was undertaken. The water used was pumped from the well following the completion of sampling. The standing water level was then allowed to stabilise before the re-introduction of the water for the permeability test. The aquifer in the well BH11was encountered and screened in sandstone. The permeability recorded is considered to be consistent with that expected in a highly fractured, sandstone strata.

The BH5 test was conducted over a relatively short period of time in comparison to the total recovery and did not achieve the recommended level of groundwater recovery. However, given the slow recovery time of the bore, it is not considered that shortfall in data collection would be likely to significantly alter the permeability test result calculated for this monitoring well. A review of the data collected indicated that the well recovery rate appeared to have largely stabilised at the time the test was ended. Therefore, extrapolation of the data is not considered to create significant uncertainty in the reported result. The limited period of the test was necessitated by equipment failure in the field, associated with faulty seals on the data logger employed. The aquifer in the well BH5 was encountered and screened in argillite bedrock. The permeability recorded is considered to be consistent with that expected in a slightly fractured, argillite strata.

Given the limitations associated with the permeability data collected to date, it is recommended that the above permeability results be used as indicative values only. If more accurate data is required for detailed design purposes, a more rigorous testing schedule for permeability should be adopted.

7 INTERPRETATION AND DISCUSSION

7.1 HYDROGEOLOGICAL CONDITIONS

7.1.1 SITE GEOLOGY

The geology of the site can be summarised from the Dorrigo – Coffs Harbour 1:250000 Geological Series Sheet SH 56-10 and 11 as follows:

- The site is in an geological zone predominantly classified as:

  - Pl - Greywacke, slate, siliceous argillite, pebbly mudstone.

- Within this main classification is a small zone at the northern end of the site classified as;

  - Ts - Conglomerate, greybilly, sandstone and claystone.

The main geological feature associated with the site is the Mihi Fault which begins approximately 10km north-east of the site and extends diagonally past the eastern side of the site. The fault passes close to the south of the site, possibly crossing the site at the southern or upper extremity, in the vicinity of BH9.

7.1.2 SITE TOPOGRAPHY

The site topography can be divided into two (2) distinct sections. The southern or upper section which is steep and heavily vegetated, and the northern or lower section which is more gently sloping and consists of open paddock. The division between the sections is generally defined by the fence line in the vicinity of the location of BH12, running east-west approximately through the centre of the site. The lower or northern portion of the site is further defined by a ridge running east-west at the northern extremity.

An intermittent waterway (dry creek) flows from west to east through the site toward the Gara River, concentrating runoff from the site and the sites immediately to the north and west. The creek is located north of the position of BH5 at the toe of the ridge. No flow was noted in the creek and it was not sampled as part of this assessment.

The nearest permanent watercourse is the Gara River, which is a fresh water environment. The Gara River is located within the Macleay River Catchment Area. The Department of Natural Resources rates water source and cumulative stress as *high* within the river, with summer extraction demand regularly exceeding available flows in November (Ref [6]), indicating that minimal recharge from groundwater inflows is likely to be occurring.

7.1.3 GROUNDWATER SURVEY

Groundwater monitoring wells were installed into the bedrock aquifer in five (5) additional bores (BH9 - BH13) during this investigation. A summary of the details of the additional monitoring wells is presented in Table 2.

Table 2 *Piezometer Summary*

Bore No.	E	N	RL (m, AHD)	Screen Depth (m)
9	383128.77	6618697.86	1014.03	53.5-59.5
10	383470.84	6618809.06	993.78	41.0-47.0
11	383204.64	6619230.01	977.58	30.0-36.0
12	383558.08	6619122.94	969.79	34.0-40.0
13	383488.09	6619373.36	961.70	16.0-22.0

Details of the two (2) existing wells BH4 and BH5, monitored as part of this assessment are presented in the January, 2007 report (Ref [1]).

Standing groundwater was encountered in all bores and the results are presented in Table 3.

Table 3 *Gauged Groundwater Depths*

Bore No.	RL (m AHD)	Stickup (m)	GW Depth from top of pipe (m)	Screen Depth (m) Below ground level	GW RL (m, AHD)
4	954.11	0.74	6.35	6.0-18.0	947.76
5	953.13	0.75	5.27	3.6-9.5	947.86
9	1014.03	0.95	46.7	53.5-59.5	967.33
10	993.78	0.67	37.0	41.0-47.0	956.78
11	977.58	0.72	28.0	30.0-36.0	949.58
12	969.79	0.62	21.3	34.0-40.0	948.49
13	961.70	0.60	13.3	16.0-22.0	948.40

Survey data from Hawkins Hook & Co site survey report May 2007 (Appendix F).

RL = reduced level

AHD = Australian Height Datum

Gauging of the standing groundwater levels allowed the groundwater flow direction to be interpolated, based on contours of hydraulic equipotential. Based on this data, the groundwater flow in the upper or southern section of the site is generally assumed to be toward the north-north east, whereas in the lower or northern section of the site flow is assumed to be more directly north-east.

Groundwater is assessed as likely to be leaving the site in a predominantly north easterly flow direction, towards the Gara River, close to the location of BH4. The direction of the groundwater flow on the site is represented on Drawing 1, Appendix A.

7.1.4 HYDRAULIC GRADIENTS

The gauging of the groundwater levels allowed the gradient of the groundwater in each section of the site. Table 4 presents the groundwater hydraulic gradient results.

Table 4 *Groundwater Hydraulic Gradient Results*

Site Section	GW RL (High)	GW RL (Low)	Distance	Gradient (m/m)
Upper	967.33 (BH9)	948.49 (BH12)	600m	3.14 x 10^{-2}
Lower	948.49 (BH12)	947.76 (BH4)	485m	1.51 x 10^{-3}

7.1.5 AQUIFER CHARACTERISATION

A trilinear plot of water chemistry of the samples is presented in Drawing 2, Appendix A to aid the assessment of groundwater geochemistry. Based on the results of the plot, a summary of the groundwater geochemistry on the site is presented in Table 5.

Table 5 *Groundwater Geochemistry*

Bore No.	Water Type	Classification
4	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO_4
5	Sulfate	Ca + Mg, Na + K Cl + SO_4, HCO_3
9	Chloride	Ca + Mg, Na + K Cl + SO_4, HCO_3
10	Calcium/Chloride	Ca + Mg, Na + K Cl + SO_4, HCO_3
11	Bicarbonate	Ca + Mg, Na + K Cl + SO_4, HCO_3
12	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO_4
13	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO_4

The above results indicate that the aquifer in the southern or upper section of the site, which is contained within the ridgeline, is predominantly a chloride water type.

In the lower or northern section of the site, the flatter topography means that the water is more likely to be influenced by influx of other water types from up gradient or south-west of the site. All groundwater sampled in this section of the site was predominantly a bicarbonate water type, except for the water in well BH5.

The water sampled in well BH5 only was a sulphate water type. BH5 is the well closest to the toe of the ridge at the northern extremity of the site. Based on field observations, this well had a significantly lower recovery rate than the other wells on the site following purging. The groundwater purged was also visually more turbid.

A review of the borelogs shows that well BH5 is screened in the argillite bedrock whereas well BH11, higher up the site to the south-west, is screened in sandstone. However, other wells screening the argillite had significantly higher recovery rates than BH5. A possible reason for the lower recovery observed in BH5 is the layer of mudstone, which was identified in BH5 immediately above the level of the argillite, but was not identified in the other bores.

The topography encountered suggests that groundwater is likely to flow predominantly from the north west toward this point on the site, given the close proximity of the ridge. This flow is in the opposite direction to the general groundwater flow direction for the majority of the subject site.

As a result, it is considered likely that the water sampled from BH5 is representative of, or is being impacted upon, by a separate aquifer to that of the majority of the site, flowing from the north back toward the low point of the site in the vicinity of BH4. Based on the limited number of wells in this section of the site, groundwater flow direction could not be accurately interpolated. However, the estimation of groundwater flow direction, based on the available data and the observed topography, is considered to give a valid representation of the flow direction in the northern section of the site.

7.1.6 AQUIFER GEOCHEMISTRY

Flowpaths through the argillite bedrock are expected to be restricted to some fractures and bedding-plane separations. Unweathered rock can contain readily soluble minerals if they are part of the rock composition. The water flowing through the rock has a longer residence time because of lower permeabilities and the slower flow rate allows longer contact with soluble minerals. The permeability is shown to be several orders of magnitude less than that for the sandstone and the residence time is likely to be in the order of years. Groundwater in passing through the sedimentary argillite bedrock would therefore be expected to have higher dissolved solids than water discharging from the sandstone or highly weathered argillite layers.

In addition to the analyses of the ion concentrations used to characterise the groundwater types encountered on the site, several other chemical groundwater quality parameters were assessed in accordance with the list provided in the required scope of works.

A brief discussion of each of these parameters and their potential effects on the groundwater quality on the site follows:

7.1.6.1 AMMONIA

Ammonia is a basic industrial chemical, a soil nutrient and a common product of human and animal wastes. Other natural sources of ammonia are lightning, volcanic activity and decomposition of plant material. Ammonia is very soluble in water, the solubility being around 100 000mgL (Ref [4]). Although the ammonia concentration in BH5 was slightly greater (<109%) than the NHNRC and NRMMC 2004 drinking water guidelines, the overall concentration of ammonia across the aquifers encountered could be considered as low, given the high potential for solubility.

7.1.6.2 CHLORIDE AND SULPHATE

Chloride is a monovalent anion and one of the major ions used to characterise groundwater quality. Sulphate is a divalent anion which is also used to characterise groundwater quality. The relatively high concentration of both ions detected in groundwater on the site is considered likely to be as a result of the long residence time of the groundwater within the predominantly argillite bedrock and the solubility of the chemical constituents of the rock.

7.1.6.3 CHLOROFORM

Chloroform is a chlorinated alkane. Chlorinated alkanes such as chloroform are formed as a by-product of the chlorination of water and waste water. Chloroform has limited use as a fumigant for foods and seeds. Chloroform has a negligible rate of hydrolysis, slow biodegradation and negligible photodegradation. The main route of loss of chlorinated alkanes from water is by evaporation (Ref [4]). Chloroform was detected in very low concentrations in two (2) wells, BH9 and BH11. The wells are on opposite sides of the site and do not have the same geochemical characterisation. Therefore, an apparent source of the chloroform detected was not noted. Given the large volumes purged prior to sampling of the wells, it is not considered likely that the chloroform detected is from a source introduced by the sampling methods. Despite a potential source of the chloroform being unknown, the chloroform detected is not currently considered to be significant given the low concentrations.

7.1.6.4 PHENOLS

Phenols are a common by-product of refining or treatment of fossil fuels. They are commonly used as a raw material in the manufacture of organic products including phenolic resins, salicyclic acid, pentachlorophenol, bisphenol-A (for polycarbonates and epoxy resins), aniline, alkyl phenols and cyclohexanol (for nylon and other fibres). They are also used as a household and industrial disinfectant (Ref [4]). Phenols have been detected in BH5 in both monitoring events undertaken to date. The concentrations detected in BH5 do not exceed the site guidelines and are falling. No likely source of phenols was observed in the vicinity of BH5. Contamination of the well due to drilling is not considered to be a likely source as the phenols were detected over several months and the bore has been subjected to repeated rigorous development.

7.1.6.5 TOTAL ORGANIC CARBON

Unless water is re-aerated efficiently such as by turbulent flow, it rapidly becomes depleted in oxygen and will not therefore support higher life forms. In addition to the micro-organism-mediated oxidation of organic matter, oxygen in water may also be consumed by the bio-oxidation of nitrogenous material and by the chemical or biological oxidation of chemical reducing agents. The degree of oxygen consumption by micro-organism-mediated oxidation of organic carbon in water is called the biochemical oxygen demand (BOD). An alternative method of measuring water quality with regards to oxygen concentrations is the total organic carbon (TOC) method. The TOC of a given water is generally measured by oxidising the carbon present in the water and detecting the CO_2 produced (Ref [7]). The available carbon reacts with oxygen molecules producing CO_2 as a product. Therefore the amount of CO_2 produced is a direct measure of the organic available for oxidation. TOC concentrations in water can be affected by the type of vegetation supported, the climate and by domestic waste water releases. The TOC concentrations detected in all wells is considered relatively low except for BH5. The TOC concentration in BH5 has risen markedly (740%) since measured in October, 2006. No apparent reason for this rise was observed.

7.1.7 IMPACT OF SURROUNDING SITE USES

It is considered that potential exists for activities on the surrounding sites to impact on the groundwater quality of the existing site. Further desktop and field investigations into the background groundwater conditions of the adjacent sites would be required to accurately assess the extent of any impact. Detailed desktop and field investigation of the background groundwater conditions surrounding the subject have not been included in this report as they are outside the proposed scope of the assessment.

7.1.8 POTENTIAL GEOTECHNICAL CONSTRAINTS

RCA report 5929-002/1; Geotechnical and Hydrogeological Investigation, Proposed Armidale Landfill, January, 2007 (Ref [1]) reported that one potential geotechnical constraint at the site related to the possible presence of a fault on the site with associated deeper weathered profile and fracturing. The drilling conditions encountered are considered likely to be due to either a subsurface void or a fault in the rock structure. The fault encountered could be part of the Mihi Fault which passes close to the southern extremity of the site. Two (2) bores were abandoned in the vicinity of BH9 due to loss of confining pressure as discussed in Section 2. The effect to groundwater of the presence of the fault/subsurface void cannot be established based on the amount of investigation undertaken to date. If further assessment of the fault/subsurface void is required, it is recommended that additional geotechnical and hydrogeological investigation be undertaken in the vicinity of the feature.

8 RECOMMENDATIONS

8.1 GROUNDWATER MONITORING PROGRAMME

Recommendations with regard to the groundwater monitoring programme were made in detail in the RCA report 5929-002/1 (Ref [1]). In summary, the report recommends that groundwater monitoring/sampling be undertaken quarterly once the landfill is operational and, where possible, this sampling should be undertaken following significant rainfall events.

It is recommended that all wells be assessed again prior to the proposed operations commencing, as the current data is not sufficient for accurate trend analyses to be undertaken. It is considered to be particularly important to include BH5 in any such monitoring events, as the aquifer in this well is exhibiting indicators of detrimental impacts from external sources.

Further desktop and field investigations of conditions on adjacent properties to the site is also recommended prior to commencing the proposed site operations as it is considered vital to establishing a defined baseline data set for the area.

It is recommended that during subsequent monitoring rounds, additional repeated permeability testing be undertaken in wells BH5 and BH11 to verify the preliminary results.

This report provides data which is supplementary to, and should be read in conjunction with, the RCA report Geotechnical and Hydrogeological Investigation, Proposed Armidale Landfill, January, 2007 (Ref [1]).

9 LIMITATIONS

This report has been prepared for Maunsell Australia Pty Ltd on behalf of Armidale-Dumaresq Council in accordance with the agreement with RCA Australia (RCA). The services performed by RCA have been conducted in a manner consistent with that generally exercised by members of its profession and consulting practice.

This report has been prepared for the sole use of Maunsell Australia Pty Ltd on behalf of Armidale-Dumaresq Council for the specific purpose and the specific proposed development described in the report. The report may not contain sufficient information for purposes or developments other than that described in the report or for parties other than Maunsell Australia Pty Ltd and Armidale-Dumaresq Council. This report shall only be presented in full and may not be used to support objectives other than those stated in the report without permission.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site. The conclusions drawn in the report are based on interpolation between boreholes or test pits. Conditions can vary between test locations that cannot be explicitly defined or inferred by investigation.

Yours faithfully
RCA AUSTRALIA

Craig Wellings
Senior Environmental Scientist

Dr Mark Allman
Manager of Geotechnical Services

REFERENCES

[1] RCA Australia, Report 5929-002/1 - *Geotechnical and Hydrogeological Investigation, Proposed Armidale Landfill*, January 2007.

[2] NSW DEC, Contaminated Sites - *Guidelines for the Assessment and Management of Groundwater Contamination*, March 2007.

[3] Australian Government - National Health and Medical Research Council/National Resource Management Ministerial Council: National Water Quality Management Strategy – *Australian Drinking Water Guidelines* 6, 2004.

[4] ANZECC, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, October 2000.

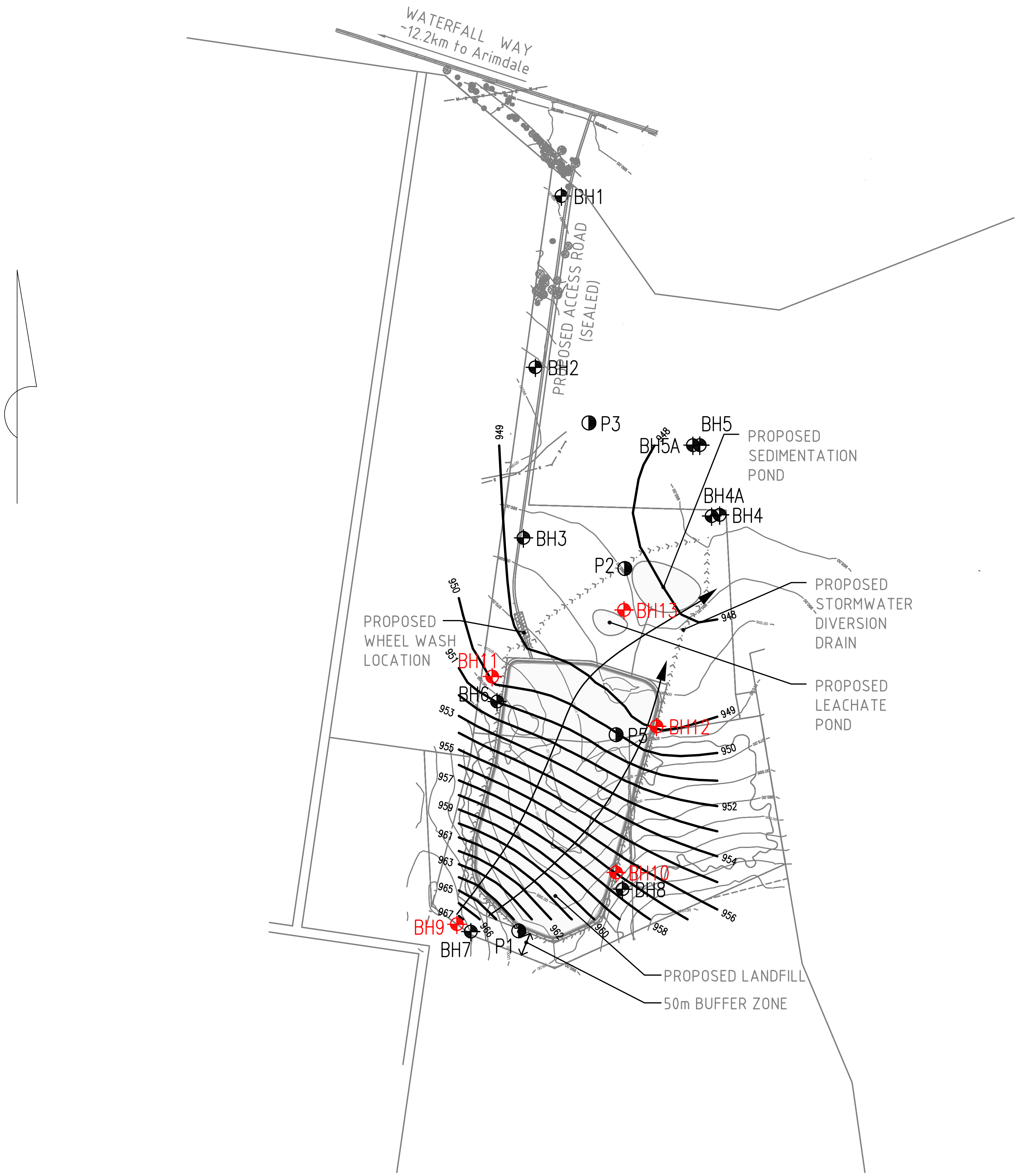
[5] NEPC, *National Environment Protection (Assessment of Site Contamination) Measure*, 1999.

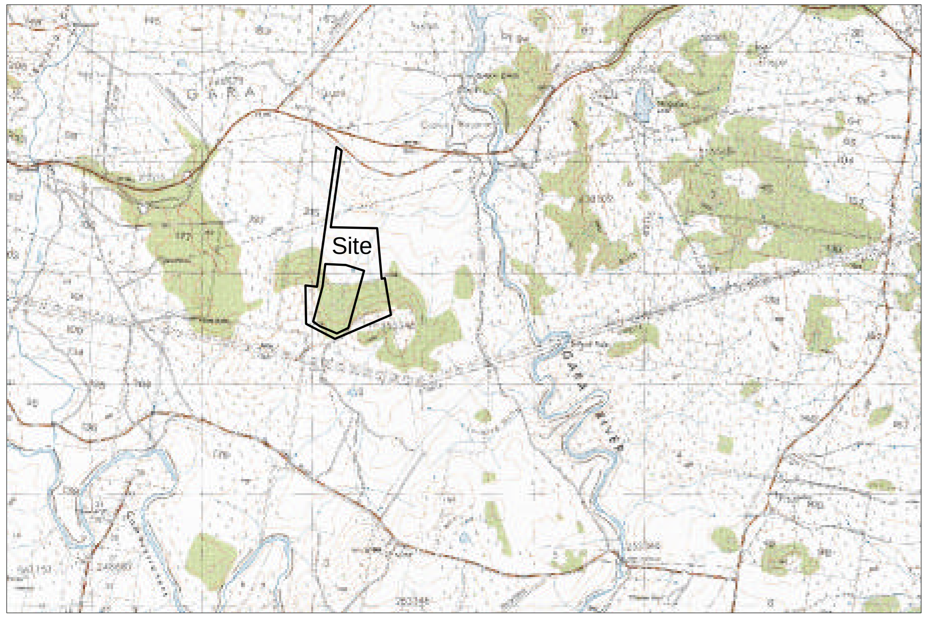
[6] Department of Natural Resources, Macro Water Planning Process - *Macleay River Catchment Area – Unregulated Water Sources*, March 2006.

[7] Freeze, RA, Cherry, JA, *Groundwater*, Prentice Hall Publishing, 1979.

Appendix A

Drawings





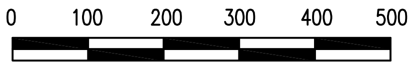
Locality Plan
N.T.S.

◐ P4

Legend

⊕	Bore Hole location (April 2007)
⊕	Bore Hole location
◐	Piezometer Location (EA Systems, 2006)
→	Groundwater flow
—	Equipotential contour

Note: Drawing adapted by plan supplied by Maunsell Australia Pty Ltd, Drawing No C005



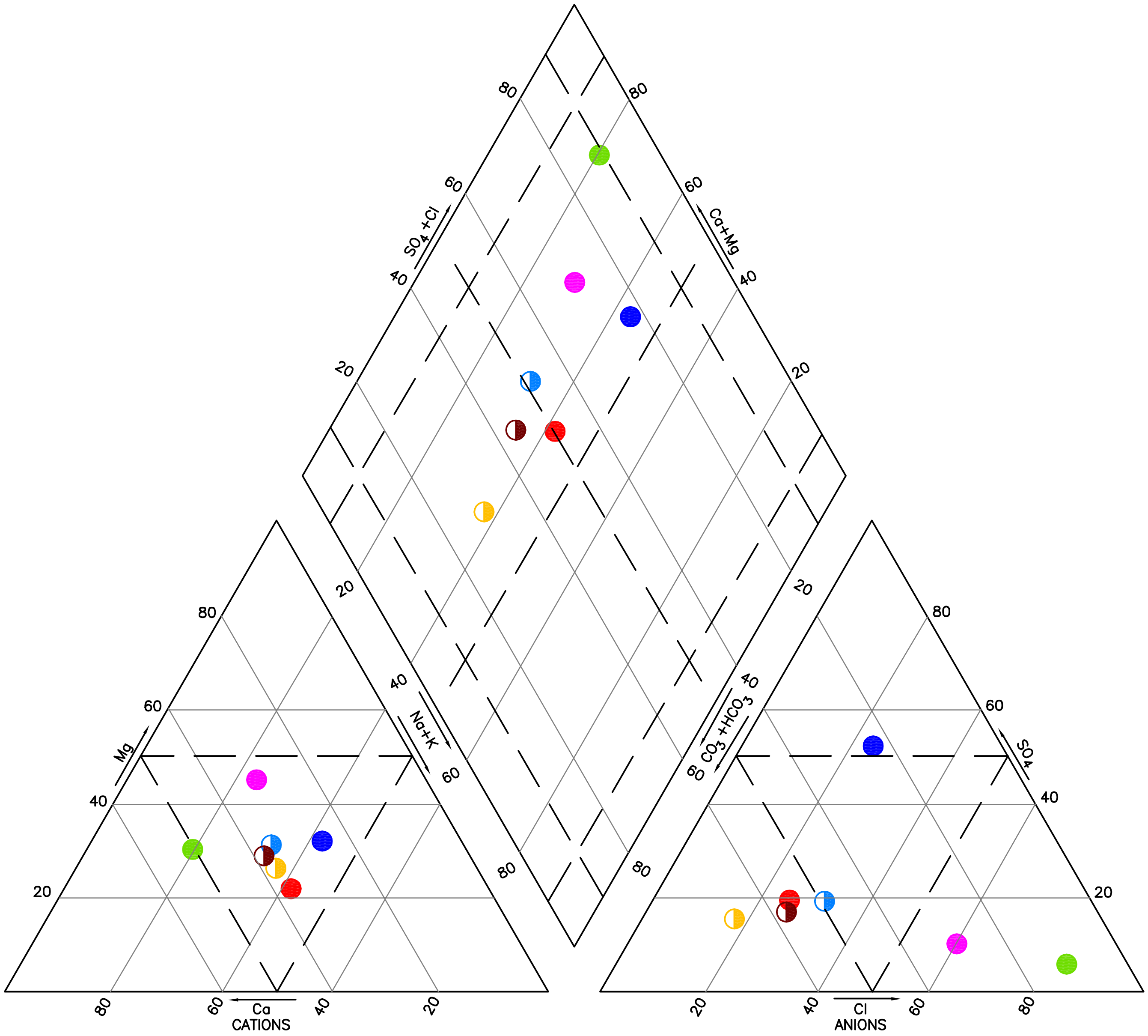
Meters

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

SITE PLAN AND
BORE HOLE LOCATION
PROPOSED ARMIDALE LAND FILL
APRIL 2007

CLIENT Maunsell Australia Pty Ltd		PROJECT No 5929	
DRAWN BY CW	SCALE 1 : 10000 (A3)	DRAWING No 1	REV 0
APPROVED BY MA	DATE 29/5/07	OFFICE NEWCASTLE	

CDT-DWG-A3H-001/1



PERCENT OF TOTAL
MILLIEQUIVALENTS PER LITRE

LEGEND

● BH4 ● BH9 ◐ BH11 ◑ BH13

● BH5 ● BH10 ◐ BH12

CDT-DWG-A4V-001/1

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

GROUNDWATER CHEMISTRY
APRIL 2007
PROPOSED ARMIDALE LANDFILL SITE

CLIENT Maunsell Australia Pty Ltd
DRAWN BY CW
SCALE As Shown
PROJECT No 5929
OFFICE Newcastle
APPROVED BY MA
DATE 29/5/07
DRAWING No 2
Rev 0

Appendix B

Engineering Logs

Symbol Index Sheet

General Soil Description Sheets

General Rock Description Sheets

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TEST BORE LOG
BORE No: BH9-LOCATION I

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: Existing
SHEET 1 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

	GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
	None Encountered		0.6		TOPSOIL, Silty/Sandy, rock outcrops and boulders up to 0.5m in diameter and some grass roots
			2.0		Fractured ROCK (MUDSTONE), interspersed with extremely weathered rock lenses
2.5					SANDSTONE, Sandy fragments and fines, dry, yellow/brown
5.0					
7.5					
10.0					
12.5					
15.0			15.0		ARGILLITE, dry, red/brown, small discrete rock fragments with powdery fines
17.5					
20.0					Becoming grey with depth, less fines
22.5					

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

CRS-TBL-A4V-002/1

RCA
AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

TEST BORE LOG
BORE No: BH9-LOCATION 1

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: Existing
SHEET 2 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
				ARGILLITE, dry, red/brown, small discrete rock fragments with powdery fines
27.5				
30.0 None encountered				
32.5				
35.0				
				36–40m Minimal recovery
37.5				
40.0				
				End Bore Hole BH9–Location 1 at 41.0m (no confining pressure in bore)
42.5				
45.0				
47.5				

LOGGED: CW	CHECKED: MA	DATE: 16/5/07

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TEST BORE LOG
BORE No: BH9-LOCATION 2

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: Existing
SHEET 1 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
				Rock outcrops and boulders up to 0.5m in diameter overlying Fractured ROCK (MUDSTONE), with extremely weathered rock and clay, slightly moist, yellow/brown
		2.0		SANDSTONE, Sandy fragments and fines, dry, yellow/brown
2.5				
5.0				Becoming darker with depth
7.5				
10.0				
12.5 None encountered				
15.0				
17.5				
20.0				
22.5				Thick clay band 23–24m

LOGGED: CW CHECKED: MA DATE: 16/5/07

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TEST BORE LOG
BORE No: BH9-LOCATION 2

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: Existing
SHEET 2 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
				SANDSTONE, Sandy fragments and fines, dry, yellow/brown
		26.0		ARGILLITE, dry, red/brown fines with discrete grey rock fragments
27.5				
30.0				No recovery >30m
32.5				
None encountered				End Bore Hole BH9-Location 2 at 33.0m (No confining pressure in bore)
35.0				
37.5				
40.0				
42.5				
45.0				
47.5				

LOGGED: CW	CHECKED: MA	DATE: 16/5/07

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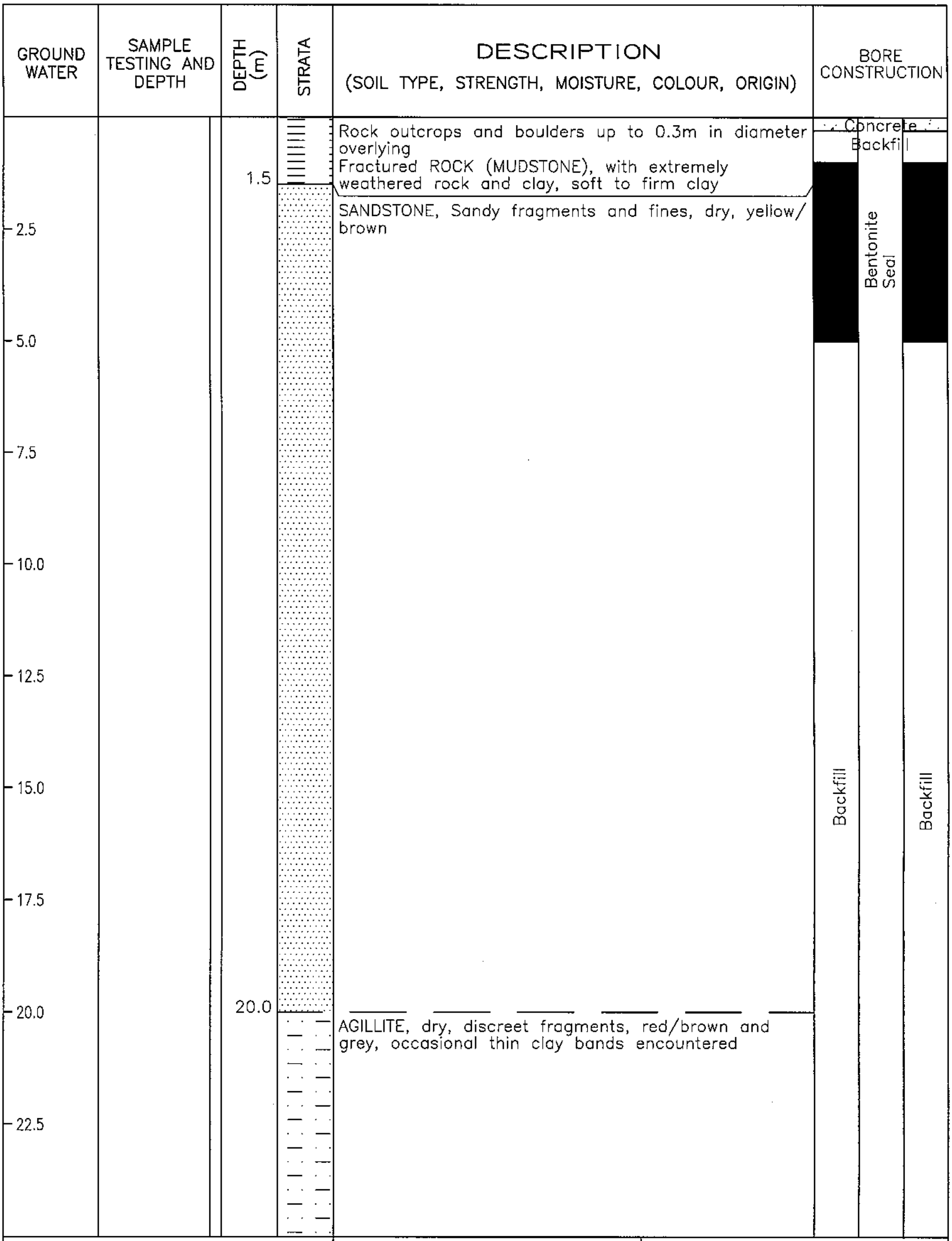
TEST BORE LOG
BORE No: BH9-LOCATION 3

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: 1014.03m, AHD
SHEET 1 of 3
METHOD OF ADVANCE: Pneumatic DHH
(Down Hole Hammer)



DEPTH (m)	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)
1.5	Rock outcrops and boulders up to 0.3m in diameter overlying Fractured ROCK (MUDSTONE), with extremely weathered rock and clay, soft to firm clay
20.0	SANDSTONE, Sandy fragments and fines, dry, yellow/ brown
	AGILLITE, dry, discreet fragments, red/brown and grey, occasional thin clay bands encountered

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LOGGED: CW	CHECKED: MA	DATE: 16/5/07

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TEST BORE LOG

BORE No: BH9-LOCATION 3

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: 1014.03m AHD
SHEET 2 of 3
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION		
				ARGILLITE, dry, discreet fragments, red/brown and grey, occasional thin clay bands encountered			
27.5							
30.0							
32.5							
35.0					Backfill		Backfill
37.5							
40.0							
42.5							
45.0							
47.5							

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

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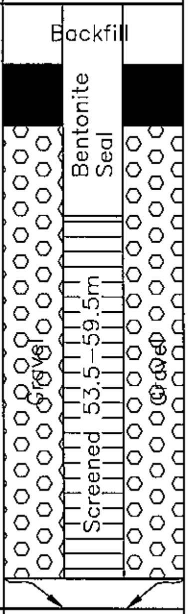
TEST BORE LOG
BORE No: BH9-LOCATION 3

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

PROJECT No: 5929
DATE: 16/4/07
SURFACE LEVEL: 1014.03m, AHD
SHEET 3 of 3
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
				ARGILLITE, dry, discreet fragments, red/brown and grey, occasional thin clay bands encountered	Backfill
				Becoming moist	Bentonite Seal
52.5					
55.0 55.0 ▽					Gravel, Screened 53.5–59.5m
57.5					
60.0				End Bore Hole BH9–Location 3 at 60.0m	
62.5					
65.0					
67.5					
70.0					
72.5					



LOGGED: CW	CHECKED: MA	DATE: 16/5/07

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TEST BORE LOG
BORE No: BH10

PROJECT No: 5929
DATE: 17/4/07
SURFACE LEVEL: 993.78m, AHD
SHEET 1 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
		7.2	▨	CLAY, firm to stiff, slightly moist, orange/brown	Bentonite Seal
2.5 5.0 7.5 10.0 12.5 15.0		16.0	░	SANDSTONE, extremely weathered, Sandy fragments and fines, dry, yellow/brown, becoming less weathered with depth	Backfill
17.5 20.0		22.0	≡	ARGILLLITE, dry, discrete fragments with powdery fines, grey	Backfill
22.5			≡	ARGILLITE, interbedded layers, dry, yellow/brown and grey	Backfill

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

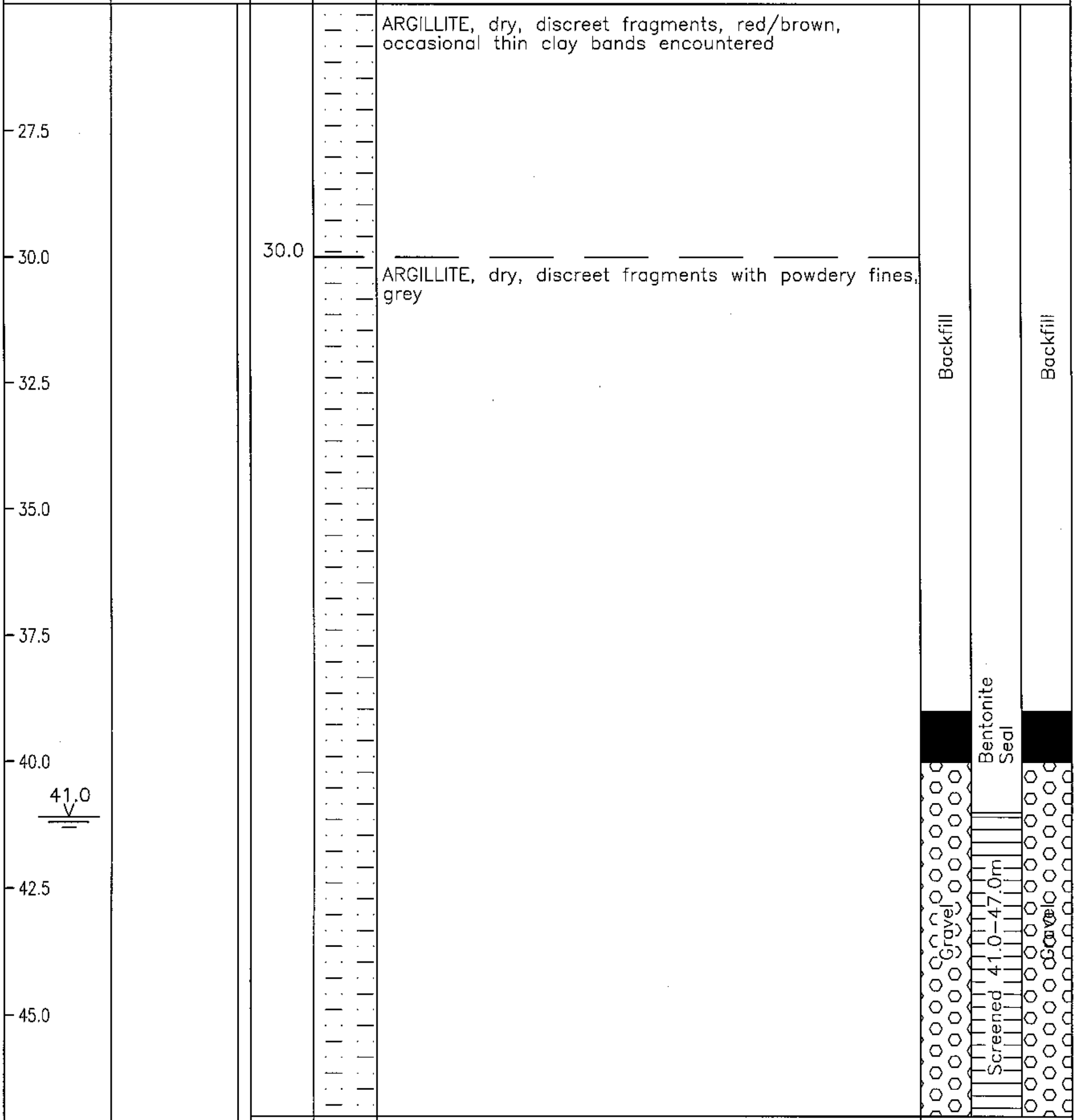
CRS-TBL-A4V-002/1

TEST BORE LOG
BORE No: BH10

PROJECT No:	5929
DATE:	17/4/07
SURFACE LEVEL:	977.58m, AHD
SHEET	2 of 2
METHOD OF ADVANCE:	Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
				ARGILLITE, dry, discreet fragments, red/brown, occasional thin clay bands encountered	
41.0		30.0		ARGILLITE, dry, discreet fragments with powdery fines, grey	
				End Bore Hole BH10 at 47.0m	



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TEST BORE LOG
BORE No: BH11

PROJECT No: 5929
DATE: 17/4/07
SURFACE LEVEL: 993.78m, AHD
SHEET 1 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
			▨	CLAY, firm to stiff, slightly moist, orange/brown, interbedded with bands of extremely weathered rock	Bentonite Seal
- 2.5		2.5	░	SANDSTONE, extremely weathered, dry, Sandy rock fragments with sandy fines, yellow/brown, becoming less weathered with depth	
- 5.0			░		
- 7.5			░		
- 10.0			░		
- 12.5			░		Backfill Backfill
- 15.0			░		
- 17.5			░		
- 20.0			░		
- 22.5			░		

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

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RCA AUSTRALIA
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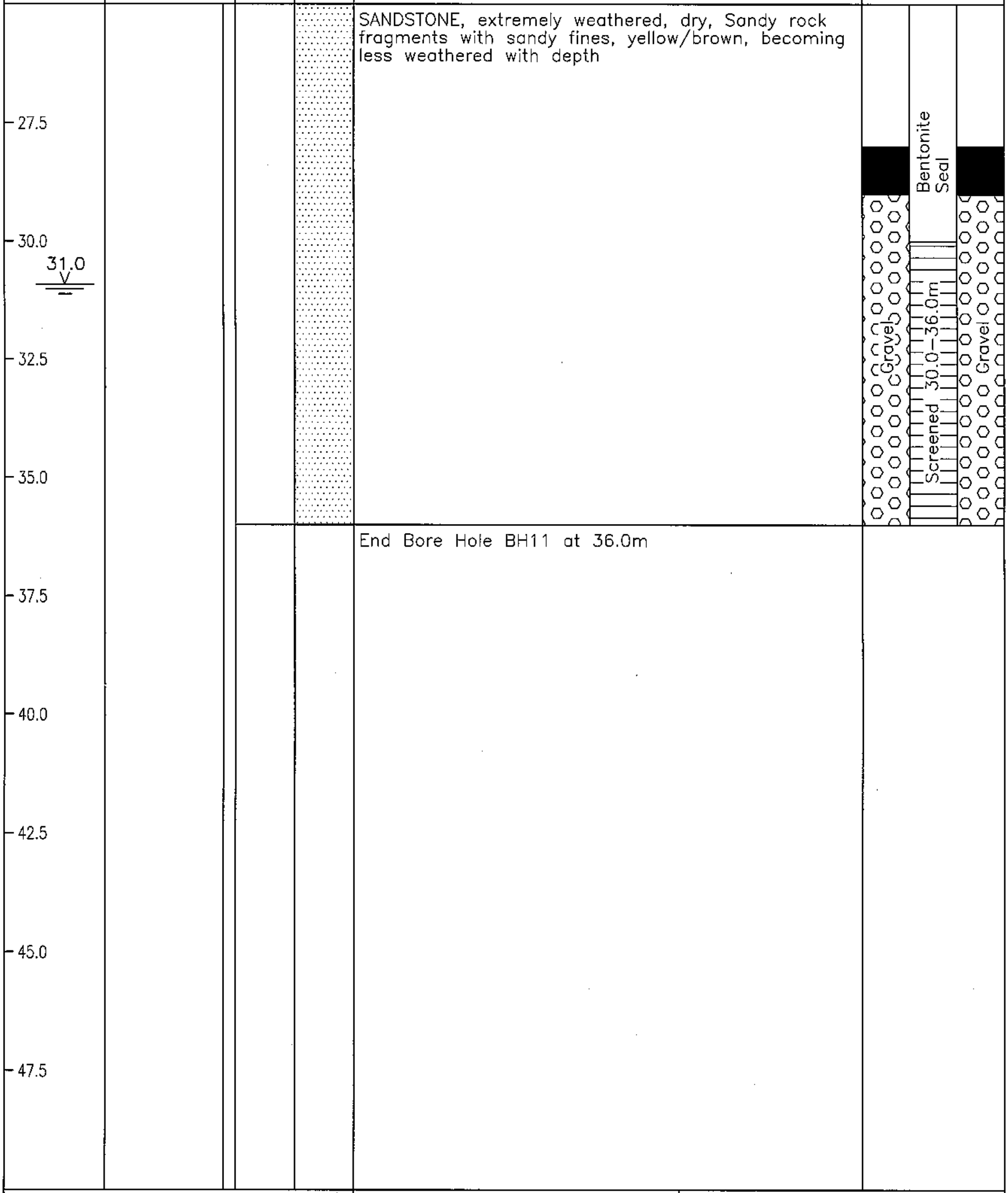
TEST BORE LOG
BORE No: BH11

PROJECT No: 5929
DATE: 17/4/07
SURFACE LEVEL: 977.58m, AHD
SHEET 2 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION



SANDSTONE, extremely weathered, dry, Sandy rock fragments with sandy fines, yellow/brown, becoming less weathered with depth

End Bore Hole BH11 at 36.0m

LOGGED: CW	CHECKED: MA	DATE: 16/5/07

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TEST BORE LOG
BORE No: BHI2

PROJECT No: 5929
DATE: 18/4/07
SURFACE LEVEL: 969.79m, AHD
SHEET 1 of 2
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
			▨	CLAY with occasional rock fragments, firm slightly moist, yellow/brown and grey	Bentonite Seal
		2.0			
2.5			░	SANDSTONE, extremely weathered, Sandy fragments with powdery fines, dry, grey/brown, becoming less weathered with depth	
5.0					
7.5					
10.0					
12.5					Backfil Backfil
15.0					
17.5					
20.0					
22.5					

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

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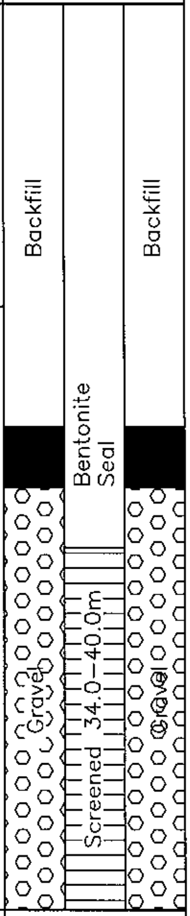
TEST BORE LOG
BORE No: BH12

CLIENT:	Maunsell Australia Pty Ltd
PROJECT:	Installation of Monitoring Wells
LOCATION:	Proposed Landfill, Armidale
PROJECT No:	5929
DATE:	18/4/07
SURFACE LEVEL:	969.79m, AHD
SHEET	2 of 2
METHOD OF ADVANCE:	Pneumatic DHH (Down Hole Hammer)

GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
				SANDSTONE, extremely weathered, Sandy fragments with powdery fines, dry, grey/brown, becoming less weathered with depth	
35.0 ▽		30.0		ARGILLITE, dry, discrete fragments, hard rock with powdery fines, grey	
		40.0		End Bore Hole BH12 at 40.0m	

Depth scale: 27.5, 30.0, 32.5, 35.0, 37.5, 40.0, 42.5, 45.0, 47.5



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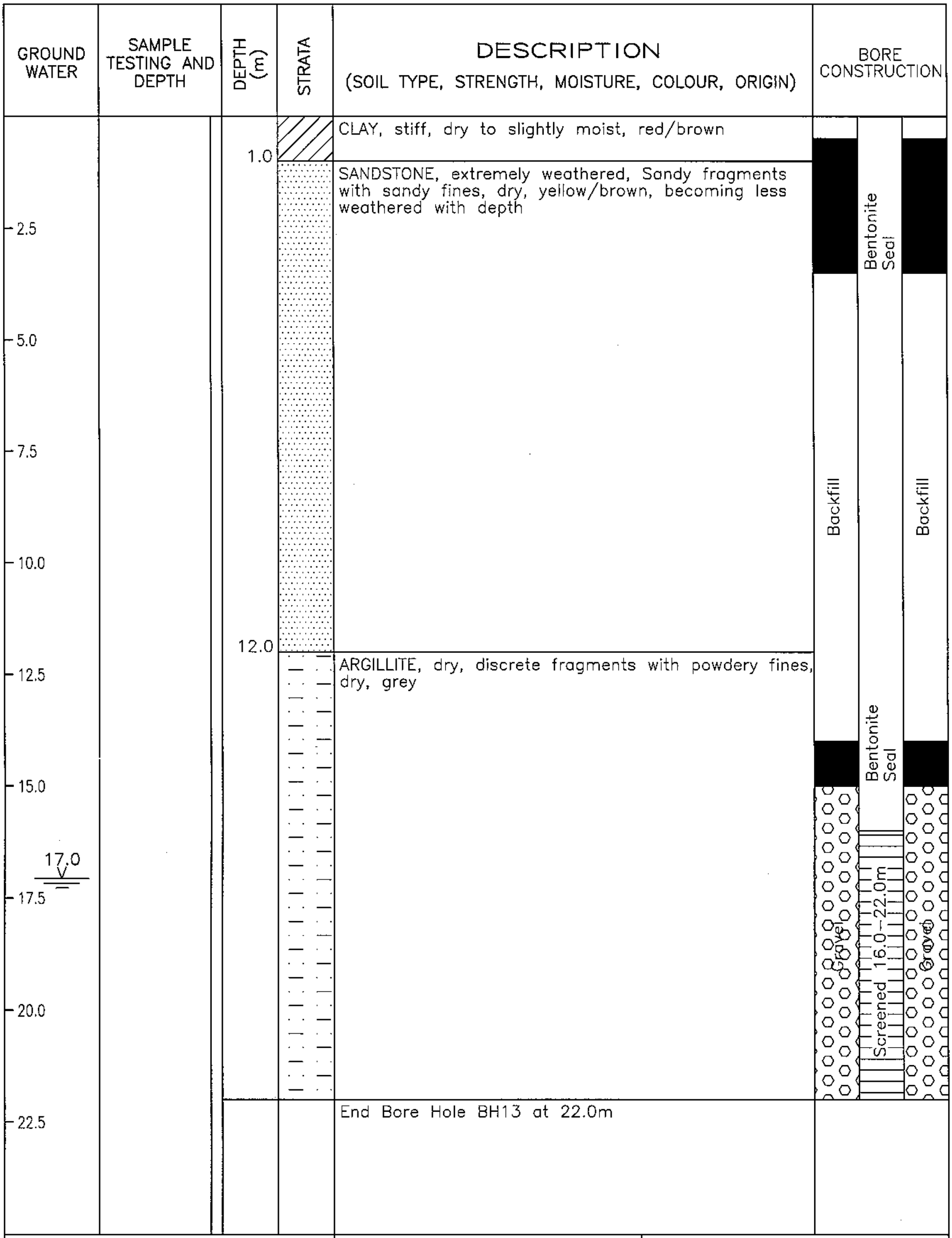
TEST BORE LOG
BORE No: BH13

PROJECT No: 5929
DATE: 18/4/07
SURFACE LEVEL: 961.7m, AHD
SHEET 1 of 1
METHOD OF ADVANCE: Pneumatic DHH (Down Hole Hammer)

CLIENT: Maunsell Australia Pty Ltd
PROJECT: Installation of Monitoring Wells
LOCATION: Proposed Landfill, Armidale



GROUND WATER	SAMPLE TESTING AND DEPTH	DEPTH (m)	STRATA	DESCRIPTION (SOIL TYPE, STRENGTH, MOISTURE, COLOUR, ORIGIN)	BORE CONSTRUCTION
		1.0		CLAY, stiff, dry to slightly moist, red/brown	
		12.0		SANDSTONE, extremely weathered, Sandy fragments with sandy fines, dry, yellow/brown, becoming less weathered with depth	
17.0				ARGILLITE, dry, discrete fragments with powdery fines, dry, grey	
				End Bore Hole BH13 at 22.0m	

LOGGED: CW
CHECKED: MA
DATE: 16/5/07

CRS-TBL-A4V-002/1

SYMBOLS INDEX SHEET

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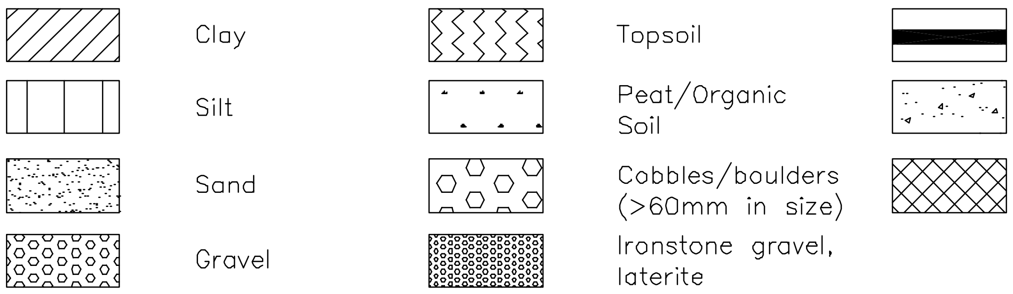
This sheet should be read in conjunction with all test hole log sheets and any idealised geological sections.

SOIL SYMBOLS

Primary Components

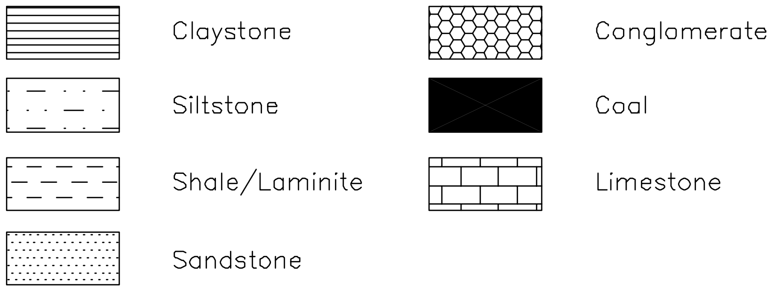


Secondary Components

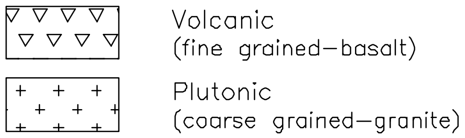
NOTE: Primary soil component shown in capitals and preceded by secondary components. Minor components noted in description. For example Sandy CLAY, with some gravel. The main component is clay with secondary sand and minor gravel. Laboratory classification testing should be undertaken where quantitative soil description is required.

ROCK SYMBOLS

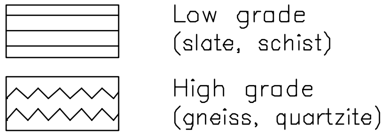
Sedimentary



Igneous



Metamorphic

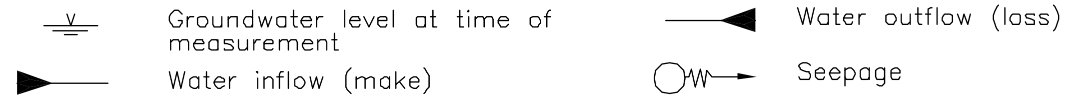


SYMBOLS

Testing and Sampling

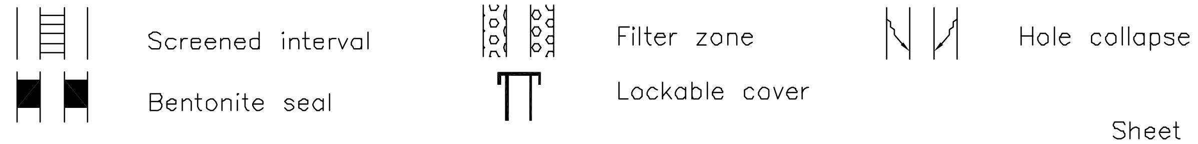
D	Disturbed sample	PP	Pocket penetrometer value (kPa)
B	Bulk sample	Sv	Shear vane, peak undrained shear strength (kPa)
U50	Undisturbed tube sample (50mm diameter)	○	Point load test (axial)
SPT	Standard penetration test	●	Point load test (diametrical)
N	SPT blows per 300mm	PID	Photoionisation detector reading (ppm) (note: comments regarding odour are based on olfactory evidence)
R	SPT refusal		

Groundwater



Groundwater levels unless otherwise indicated refer to the level of free water encountered in the bores or test holes at the time of measurement. The actual groundwater level may differ depending on material permeability, climate, tides etc.

Well Construction



GENERAL SOIL DESCRIPTION SHEET

This sheet should be read in conjunction with all test hole log sheets and any idealised geological sections.

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SOIL DESCRIPTION

Descriptive Terms

Cohesive	– Soils that exhibit cohesion or bonding between particles (ie clay, silt).
Granular	– Soils that have little cohesion or bonding between particles (ie sand, gravel).
Dry	– Looks and feels dry. Dry cohesive soils are hard, friable or powdery and dry granular soils are cohesionless and free running.
Moist	– Soil feels cool and looks dark in colour. Moist cohesive soils can be moulded and moist granular soils tend to cohere.
Wet	– Free water present.
Cemented	– Secondary bonding between soil particles. Weakly cemented soils are easily broken up by hand.

SOIL GRAIN SIZE

CLAY	SILT	SAND			GRAVEL			COBBLES	BOULDERS
		Fine	Medium	Coarse	Fine	Medium	Coarse		
0.002mm	0.06mm	0.2mm	0.6mm	2mm	6mm	20mm	60mm	200mm	

SOIL STRENGTH

Consistency of Cohesive Soils[1]

Term	Pocket Penetrometer Value (kPa)	Field Guide
Very soft	<25	Surface Penetrated by fist
Soft	25-50	Easily penetrated by thumb
Firm	50-100	Penetrated by thumb with effort
Stiff	100-200	
Very stiff	200-400	Indented by thumb
Hard	>400	Surface only marked by thumbnail

Density of Granular Soils[2]

Term	Density Index (%)
Very loose	<15
Loose	15-35
Medium dense	35-65
Dense	65-85
Very dense	85-100

NOTE: 1. Consistency can be assessed based on insitu testing or laboratory testing on undisturbed samples. Undrained shear strengths can be estimated from field pocket penetrometer values by dividing by 2. Quantification of undrained shear strength should be based on insitu or laboratory testing.

2. Density can only be assessed on the basis of insitu testing

SOIL ORIGIN

Weathered in Place Soils

Residual soil	– Rock completely broken down to soil, no rock structure visible.
Extremely weathered material	– Rock predominantly broken down to soil with some relict rock structure present.

Transported Soils

Alluvial soil	– Deposited by streams and rivers.
Slopewash soils	– Deposited on slopes by gravity and sheet flow.
Aeolian soils	– Deposited by wind.
Lacustrine soils	– Deposited in lakes.
Marine soils	– Deposited in bays, beaches and estuaries.
Slide debris	– Deposited by mass movement (colluvium).
Fill	– Deposited by man.

GENERAL ROCK DESCRIPTION SHEET

This sheet should be read in conjunction with all test hole log sheets and any idealised geological sections.

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The following rock description is intended for the geotechnical logging of diamond drill core and is also applicable for the mapping of natural exposures and cuttings.

In most rocks the presence of defects and the effects of weathering have a significant influence on the engineering behaviour of the rock mass.

The term **rock substance** refers to the description of material characteristics such as rock type, grain size, colour, strength and weathering.

The term **rock mass** refers to the properties of the overall rock mass/body and involves description of defects (discontinuities or fractures in the rock substance such as joints, faults bedding partings etc), weathering and structure.

ROCK SUBSTANCE – DESCRIPTIVE TERMS

Rock name : Simple rock names are used rather than precise geological classifications.

I_s(50) : Point load strength index.

Grain size/ type : The grains of a rock can be described in terms of size (mm) and shape on the basis of appropriate terms used in the General Soil Description Sheet. Where identified, individual minerals should be described.

Strength : Strength is estimated on the basis of tactile appraisal and confirmed by point load strength testing where shown. The rock strength description refers to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects. Unconfined compressive strength testing should be undertaken where rock strengths need to be quantified.

Term	Symbol	I_s(50) MPa	Field Guide (The core refers to 150mm long x 50mm dia. sample)
Extremely Low	EL	<0.03	Soil strength property description appropriate
Very Low	VL	0.03-0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.
Low	L	0.1-0.3	The core may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium	M	0.3-1.0	The core may be broken by hand with considerable difficulty. Readily scored with knife
High	H	1.0-3.0	The core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
Very High	VH	3.0-10.0	The core may be broken with hand held hammer. Cannot be scratched with knife.
Extremely High	EH	>10.0	The core is difficult to break with hand held hammer. Rings when struck with hammer.

*I_S (50) = Point load strength index

Weathering :

Term	Symbol	Definition
Extremely Weathered	EW	The rock exhibits soil-like properties though the texture of the original rock is still evident.
Highly Weathered	HW	Limonite staining or colour change affects the whole of the rock mass. Signs of chemical or physical decomposition is evident throughout the whole of the rock mass.
Moderately Weathered	MW	Staining extends throughout the whole of the rock mass and the original colour is no longer recognisable.
Slightly Weathered	SW	Partial staining or decolouration of the rock mass, usually by limonite, has taken place.
Fresh	F	Rock mass unaffected by weathering.

The assignment of rock weathering terms is subjective and is used for identification purposes only

GENERAL ROCK DESCRIPTION SHEET

This sheet should be read in conjunction with all test hole log sheets and any idealised geological sections.

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ROCK MASS – DESCRIPTIVE TERMS

Defects : **Defects** are fractures in the rock mass and include joints, faults, shear planes, cleavages and bedding partings. Description of defects is important as defects generally control the overall engineering behaviour of the rock mass.

Defect spacing refers to the degree of fracturing or spacing of all natural fractures. Artificial fractures induced by drilling, boxing or transport of rock core are not included in the defect spacing log. The delineation of artificial fractures is subjective.

Defect Description

Type :	Parting	(along rock layering/bedding)
	Joint	(across rock layering/bedding)
	Shear	(zone or seam of rock movement resulting in crushing/fracturing)
	Clayey seam	(infilled or extremely weathered layer)
	Vein	(secondary mineralisation along a fracture)
Shape :	Planar	
	Curved	
	Undulose/Stepped	
	Irregular	
Roughness :	Rough	
	Smooth	
	Striated	(slickenside, indicative of shear movement)
Infill :	Clean	(defect surfaces clean)
	Stained	(surfaces stained by limonite (iron–oxide) or similar)
	Veneer	(thin surface coating $\leq$1mm thick)
	Coating	(surface coating 1mm–5mm thick)
	Seam	(5mm–100mm thick)
	Zone	(>100mm thick)

Orientation of defects is described relative to the horizontal.

Dip = the maximum angle of a defect plane relative to the horizontal surface

Strike = orientation relative to magnetic north of the line of intersection of a defect plane and the horizontal surface

Structure : Structure refers to larger scale rock mass features such as bedding, folding, lineation and flow banding etc. Where no structure is discernible the term massive is used.
In sedimentary rocks the following terms can be used to describe the spacing of bedding/stratification.

Term	Spacing of Bedding (mm)
Laminated	<20
Thinly bedded	20–200
Medium bedded	200–600
Thickly bedded	600–2000
Very thickly bedded	>2000

Appendix C

Results Summary Table

Sample ID	PQL	95% Fresh ^{A}	BH4	BH5	BH9	BH10	BH11	BH12	BH13
Date			20/04/2007	20/04/2007	18/04/2007	19/04/2007	19/04/2007	19/04/2007	19/04/2007
Sample Purpose			Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Sample Appearance			Mod turbid	Mod turbid	Clear	Clear	Slt Turbid	Clear	Slt turbid
Sample collected by			CW	CW	CW	CW	CW	CW	CW
Physical Parameters									
Field pH			7.61	7.76	7.63	7.63	7.71	7.54	7.71
pH (pH units)	0.01	6.5 - 9.0	6.77	7.51	6.82	6.79	6.84	6.74	6.74
Alkalinity									
Hydroxide Alkalinity as CaCO3	1000		<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	1000		<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	1000		577	826	219	274	388	547	458
Total Alkalinity as CaCO3	1000		577	826	219	274	388	547	458
Dissolved Major Anions									
Sulphate	1000		149	1480	56	66	104	87	101
Disolved Major Cations									
Calcium	1000		135	335	58	339	89	114	114
Magnesium	1000		52	254	68	118	49	43	44
Sodium	1000		178	655	75	149	103	131	122
Potassium	1000		1	5	8	4	<1	1	1
Fluoride									
Fluoride	100		0.3	0.3	0.6	0.1	0.2	0.2	0.2
Chloride									
Chloride	1000		141	489	260	928	116	76.6	120
NOx									
Nitrite	10		0.033	0.026	0.005	0.005	0.005	0.005	0.014
Nitrate as N	10	700	0.149	0.005	0.833	4.36	0.311	0.112	0.158
Nitrite + Nitrate as N	10		0.182	0.031	0.838	4.365	0.316	0.117	0.172
Ionic Balance									
Total Anions (meq/L)	10		18.6	61.1	12.9	33	13.2	14.9	14.6
Total Cations (meq/L)	10		18.8	66.2	12	33.3	13	15	14.6
Ionic Balance (%)	10		0.53	3.94	3.63	0.42	0.88	0.3	0.05
Heavy Metals									
Iron	50	*300*	1.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese	1	1900	1.4	0.594	0.35	0.018	0.047	0.042	0.068
Non Metallic Inorganics									
Ammonia as N	10	900	0.158	0.543	0.175	0.417	0.111	0.131	0.108
Total Organic Carbon									
TOC	1000		6	37	3	4	3	4	5
Phenols									
Total Phenols	50	320	<0.050	0.085	<0.050	<0.050	<0.050	<0.050	<0.050
Fumigants									
2.2-Dichloropropane	5		<5	<5	<5	<5	<5	<5	<5
1.2-Dichloropropane	5	*900*	<5	<5	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	5		<5	<5	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	5		<5	<5	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	5		<5	<5	<5	<5	<5	<5	<5
Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	50		<50	<50	<50	<50	<50	<50	<50
Chloromethane	50		<50	<50	<50	<50	<50	<50	<50
Vinyl chloride	50		<50	<50	<50	<50	<50	<50	<50
Bromomethane	50		<50	<50	<50	<50	<50	<50	<50
Chloroethane	50		<50	<50	<50	<50	<50	<50	<50
Trichlorofluoromethane	50		<50	<50	<50	<50	<50	<50	<50
1.1-Dichloroethene	5		<5	<5	<5	<5	<5	<5	<5
Iodomethane	5		<5	<5	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	5		<5	<5	<5	<5	<5	<5	<5
1.1-Dichloroethane	5	*90*	<5	<5	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	5		<5	<5	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	5	*270*	<5	<5	<5	<5	<5	<5	<5
1.1-Dichloropropylene	5		<5	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	5	*240*	<5	<5	<5	<5	<5	<5	<5
1.2-Dichloroethane	5	*1900*	<5	<5	<5	<5	<5	<5	<5
Trichloroethene	5		<5	<5	<5	<5	<5	<5	<5
Dibromomethane	5		<5	<5	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	5	6500	<5	<5	<5	<5	<5	<5	<5
1.3-Dichloropropane	5	*0.1*	<5	<5	<5	<5	<5	<5	<5
Tetrachloroethene	5		<5	<5	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	5		<5	<5	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	5		<5	<5	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	5		<5	<5	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	5	*400*	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	5		<5	<5	<5	<5	<5	<5	<5
Pentachloroethane	5	*80*	<5	<5	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	5		<5	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	5		<5	<5	<5	<5	<5	<5	<5
Halogenated Aromatic Compounds									
Chlorobenzene	5		<5	<5	<5	<5	<5	<5	<5
Bromobenzene	5		<5	<5	<5	<5	<5	<5	<5
2-Chlorotoluene	5		<5	<5	<5	<5	<5	<5	<5
4-Chlorotoluene	5		<5	<5	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	5	260	<5	<5	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	5	60	<5	<5	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	5	160	<5	<5	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	5	170	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	5	10	<5	<5	<5	<5	<5	<5	<5
Trihalomethanes									
Chloroform	5	*370*	<5	<5	6	<5	6	<5	<5
Bromodichloromethane	5		<5	<5	<5	<5	<5	<5	<5
Dibromochloromethane	5		<5	<5	<5	<5	<5	<5	<5
Bromoform	5		<5	<5	<5	<5	<5	<5	<5

All results in µg/L
PQL = Practical Quantitation Limit.
^{A} ANZECC 2000 95% Protection Level for Fresh Water
Guidelines in *italics* are low level reliability guidelines
Total Phenolics guideline based on Phenol
Results shown in **BOLD** are in excess of the primary acceptance criteria: 95% Fresh

Appendix D

Laboratory Certificates of Analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: ROBERT CARR & ASSOCIATES P/L	*Laboratory*	: Environmental Division Sydney	*Page*	: 1 of 9
Contact	: MR CRAIG WELLINGS	*Contact*	: Victor Kedicioglu	*Work Order*	: ES0705218
Address	: P O BOX 175 CARRINGTON NSW AUSTRALIA 2294	*Address*	: 277-289 Woodpark Road Smithfield NSW Australia 2164		
E-mail	: craigw@rca.com.au	*E-mail*	: Victor.Kedicioglu@alsenviro.com		
Telephone	: 49029200	*Telephone*	: 61-2-8784 8555		
Facsimile	: 49029299	*Facsimile*	: 61-2-8784 8500		
Project	: 5929	*Quote number*	: SY/099/06	*Date received*	: 23 Apr 2007
Order number	: - Not provided -			*Date issued*	: 1 May 2007
C-O-C number	: 202536			*No. of samples*	- *Received* : 7
Site	: - Not provided -				*Analysed* : 7

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory
825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Ankit Joshi		Inorganics - NATA 825 (10911 - Sydney)
Celine Conceicao	Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)
Ken Reid	Manager	Newcastle - NATA 825 (1656 - Newcastle)
Rassem Ayoubi	Senior Organic Chemist	Organics - NATA 825 (10911 - Sydney)

Comments

This report for the ALSE reference ES0705218 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **ES0705218**

It has been noted that NO2 is greater than NOX (sample ID BH5), however this difference is within the limits of experimental variation.

Analytical Results

			Client Sample ID :	BH9	BH10	BH11	BH12	BH13
			Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
			Sample Date / Time :	18 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00
			Laboratory Sample ID :					
Analyte	*CAS number*	*LOR*	*Units*	ES0705218-001	ES0705218-002	ES0705218-003	ES0705218-004	ES0705218-005
EA005: pH								
pH Value		0.01	pH Unit	6.82	6.79	6.84	6.74	6.74
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	219	274	388	547	458
Total Alkalinity as CaCO3		1	mg/L	219	274	388	547	458
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	56	66	104	87	101
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	260	928	116	76.6	120
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	58	339	89	114	114
Magnesium	7439-95-4	1	mg/L	68	118	49	43	44
Sodium	7440-23-5	1	mg/L	75	149	103	131	122
Potassium	7440-09-7	1	mg/L	8	4	<1	1	1
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.350	0.018	0.047	0.042	0.068
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.6	0.1	0.2	0.2	0.2
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.010	mg/L	0.175	0.417	0.111	0.131	0.108
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	<0.010	<0.010	<0.010	<0.010	0.014
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.833	4.36	0.311	0.112	0.158
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.833	4.36	0.311	0.112	0.172
EN055: Ionic Balance								
Total Anions		0.01	meq/L	12.9	33.0	13.2	14.9	14.6
Total Cations		0.01	meq/L	12.0	33.3	13.0	15.0	14.6
Ionic Balance		0.01	%	3.63	0.42	0.88	0.30	0.05
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	3	4	3	4	5
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)		0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050

Analytical Results

			Client Sample ID :	BH9	BH10	BH11	BH12	BH13
			Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
			Sample Date / Time :	18 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00
			Laboratory Sample ID :	ES0705218-001	ES0705218-002	ES0705218-003	ES0705218-004	ES0705218-005
Analyte	*CAS number*	*LOR*	*Units*					
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	<5	<5	<5
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	<50	<50	<50
Chloromethane	74-87-3	50	µg/L	<50	<50	<50	<50	<50
Vinyl chloride	75-01-4	50	µg/L	<50	<50	<50	<50	<50
Bromomethane	74-83-9	50	µg/L	<50	<50	<50	<50	<50
Chloroethane	75-00-3	50	µg/L	<50	<50	<50	<50	<50
Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	<50	<50	<50
1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	<5	<5	<5
Iodomethane	74-88-4	5	µg/L	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	<5	<5	<5
Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	<5	<5	<5
Trichloroethene	79-01-6	5	µg/L	<5	<5	<5	<5	<5
Dibromomethane	74-95-3	5	µg/L	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	<5	<5	<5
1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	<5	<5	<5
Tetrachloroethene	127-18-4	5	µg/L	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	<5	<5	<5
Pentachloroethane	76-01-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	<5	<5	<5
Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	<5	<5	<5
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	5	µg/L	<5	<5	<5	<5	<5
Bromobenzene	108-86-1	5	µg/L	<5	<5	<5	<5	<5

Analytical Results

			Client Sample ID :	**BH9**	**BH10**	**BH11**	**BH12**	**BH13**
			Sample Matrix Type / Description :	WATER	WATER	WATER	WATER	WATER
			Sample Date / Time :	18 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00	19 Apr 2007 15:00
			Laboratory Sample ID :					
Analyte	***CAS number***	***LOR***	***Units***	**ES0705218-001**	**ES0705218-002**	**ES0705218-003**	**ES0705218-004**	**ES0705218-005**
EP074F: Halogenated Aromatic Compounds								
2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	<5	<5	<5
4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	<5	<5	<5
EP074G: Trihalomethanes								
Chloroform	67-66-3	5	µg/L	6	<5	6	<5	<5
Bromodichloromethane	75-27-4	5	µg/L	<5	<5	<5	<5	<5
Dibromochloromethane	124-48-1	5	µg/L	<5	<5	<5	<5	<5
Bromoform	75-25-2	5	µg/L	<5	<5	<5	<5	<5
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	106	118	115	112	111
Toluene-D8	2037-26-5	0.1	%	97.3	107	102	101	98.7
4-Bromofluorobenzene	460-00-4	0.1	%	97.6	101	102	101	98.0

Analytical Results

			Client Sample ID :	**BH4**	**BH5**			
			Sample Matrix Type / Description :	WATER	WATER			
			Sample Date / Time :	20 Apr 2007 15:00	20 Apr 2007 15:00			
			Laboratory Sample ID :					
Analyte	***CAS number***	***LOR***	***Units***	**ES0705218-006**	**ES0705218-007**			
EA005: pH								
pH Value		0.01	pH Unit	6.77	7.51			
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	577	826			
Total Alkalinity as CaCO3		1	mg/L	577	826			
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	149	1480			
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	141	489			
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	135	335			
Magnesium	7439-95-4	1	mg/L	52	254			
Sodium	7440-23-5	1	mg/L	178	655			
Potassium	7440-09-7	1	mg/L	1	5			
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	1.40	0.594			
Iron	7439-89-6	0.05	mg/L	1.30	<0.05			
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.3	0.3			
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.010	mg/L	0.158	0.543			
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.033	0.026			
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.149	<0.010			
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.182	<0.010			
EN055: Ionic Balance								
Total Anions		0.01	meq/L	18.6	61.1			
Total Cations		0.01	meq/L	18.8	66.2			
Ionic Balance		0.01	%	0.53	3.94			
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon		1	mg/L	6	37			
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)		0.050	mg/L	<0.050	0.085			

Analytical Results

			Client Sample ID :	**BH4**	**BH5**			
			Sample Matrix Type / Description :	WATER	WATER			
			Sample Date / Time :	20 Apr 2007 15:00	20 Apr 2007 15:00			
			Laboratory Sample ID :	**ES0705218-006**	**ES0705218-007**			
Analyte	*CAS number*	*LOR*	*Units*					
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5			
1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5			
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5			
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5			
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5			
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50			
Chloromethane	74-87-3	50	µg/L	<50	<50			
Vinyl chloride	75-01-4	50	µg/L	<50	<50			
Bromomethane	74-83-9	50	µg/L	<50	<50			
Chloroethane	75-00-3	50	µg/L	<50	<50			
Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50			
1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5			
Iodomethane	74-88-4	5	µg/L	<5	<5			
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5			
1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5			
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5			
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5			
1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5			
Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5			
1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5			
Trichloroethene	79-01-6	5	µg/L	<5	<5			
Dibromomethane	74-95-3	5	µg/L	<5	<5			
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5			
1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5			
Tetrachloroethene	127-18-4	5	µg/L	<5	<5			
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5			
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5			
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5			
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5			
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5			
Pentachloroethane	76-01-7	5	µg/L	<5	<5			
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5			
Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5			
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	5	µg/L	<5	<5			
Bromobenzene	108-86-1	5	µg/L	<5	<5			

Analytical Results

			Client Sample ID :	**BH4**	**BH5**			
			Sample Matrix Type / Description :	WATER	WATER			
			Sample Date / Time :	20 Apr 2007 15:00	20 Apr 2007 15:00			
			Laboratory Sample ID :	**ES0705218-006**	**ES0705218-007**			
Analyte	*CAS number*	*LOR*	*Units*					
EP074F: Halogenated Aromatic Compounds								
2-Chlorotoluene	95-49-8	5	µg/L	<5	<5			
4-Chlorotoluene	106-43-4	5	µg/L	<5	<5			
1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5			
1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5			
1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5			
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5			
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5			
EP074G: Trihalomethanes								
Chloroform	67-66-3	5	µg/L	<5	<5			
Bromodichloromethane	75-27-4	5	µg/L	<5	<5			
Dibromochloromethane	124-48-1	5	µg/L	<5	<5			
Bromoform	75-25-2	5	µg/L	<5	<5			
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	113	117			
Toluene-D8	2037-26-5	0.1	%	104	106			
4-Bromofluorobenzene	460-00-4	0.1	%	102	110			

Surrogate Control Limits

Matrix Type: WATER - Surrogate Control Limits — ***Surrogate Control Limits***

Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP074: Volatile Organic Compounds			
EP074S: VOC Surrogates	1,2-Dichloroethane-D4	80	120
	Toluene-D8	88	110
	4-Bromofluorobenzene	86	115

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QUALITY CONTROL REPORT

Client : **ROBERT CARR & ASSOCIATES P/L**
Contact : MR CRAIG WELLINGS
Address : P O BOX 175 CARRINGTON
NSW AUSTRALIA 2294

Project : 5929
Order number : - Not provided -
C-O-C number : 202536
Site : - Not provided -

E-mail : craigw@rca.com.au
Telephone : 49029200
Facsimile : 49029299

Laboratory : Environmental Division Sydney
Contact : Victor Kedicioglu
Address : 277-289 Woodpark Road Smithfield
NSW Australia 2164

Quote number : SY/099/06

E-mail : Victor.Kedicioglu@alsenviro.com
Telephone : 61-2-8784 8555
Facsimile : 61-2-8784 8500

Page : **1 of 14**

Work order : **ES0705218**

Amendment No. :
Date received : **23 Apr 2007**
Date issued : **1 May 2007**

No. of samples
Received : 7
Analysed : 7

This final report for the ALSE work order reference ES0705218 supersedes any previous reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments
It has been noted that NO2 is greater than NOX (sample ID BH5), however this difference is within the limits of experimental variation.

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WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

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Accredited for compliance with ISO/IED 17025

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Ankit Joshi	Inorganics - NATA 825 (10911 - Sydney)
Celine Conceicao	Inorganics - NATA 825 (10911 - Sydney)
Ken Reid	Newcastle - NATA 825 (1656 - Newcastle)
Rassem Ayoubi	Organics - NATA 825 (10911 - Sydney)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: **LOR** = Limit of Reporting, **RPD** = Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA005: pH						
EA005: pH - (QC Lot: 399141)				**pH Unit**	**pH Unit**	**%**
ES0705218-007	BH5	pH Value	0.01 pH Unit	7.51	7.52	0.1
ES0705359-001	Anonymous	pH Value	0.01 pH Unit	7.66	7.61	0.6
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 399579)				**mg/L**	**mg/L**	**%**
ES0705152-001	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	353	353	0.0
		Total Alkalinity as CaCO3	1 mg/L	353	353	0.0
ES0705174-008	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	20	20	0.0
		Total Alkalinity as CaCO3	1 mg/L	20	20	0.0
ED037P: Alkalinity by PC Titrator - (QC Lot: 399581)				**mg/L**	**mg/L**	**%**
ES0705218-007	BH5	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	826	821	0.6
		Total Alkalinity as CaCO3	1 mg/L	826	821	0.6
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 396735)				**mg/L**	**mg/L**	**%**
ES0705187-001	Anonymous	Sulphate as SO4 2-	1 mg/L	39	39	0.0
ES0705218-005	BH13	Sulphate as SO4 2-	1 mg/L	101	101	0.0
ED045G: Chloride Discrete analyser						
ED045G: Chloride Discrete analyser - (QC Lot: 397082)				**mg/L**	**mg/L**	**%**
ES0705217-001	Anonymous	Chloride	1.0 mg/L	31.4	31.1	1.0
ES0705218-007	BH5	Chloride	1.0 mg/L	489	485	0.7

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 396734)				mg/L	mg/L	%
ES0705187-001	Anonymous	Calcium	1 mg/L	10	10	0.0
		Magnesium	1 mg/L	8	8	0.0
		Sodium	1 mg/L	38	38	0.0
		Potassium	1 mg/L	4	4	0.0
ES0705218-005	BH13	Calcium	1 mg/L	114	114	0.0
		Magnesium	1 mg/L	44	44	0.0
		Sodium	1 mg/L	122	124	1.6
		Potassium	1 mg/L	1	1	0.0
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 397312)				mg/L	mg/L	%
EP0701582-001	Anonymous	Manganese	0.001 mg/L	0.144	0.151	4.5
		Iron	0.05 mg/L	2.77	2.88	3.7
ES0705221-002	Anonymous	Manganese	0.001 mg/L	1.23	1.17	5.2
		Iron	0.05 mg/L	0.81	0.73	10.1
EK040P: Fluoride by PC Titrator						
EK040P: Fluoride by PC Titrator - (QC Lot: 399580)				mg/L	mg/L	%
ES0705152-001	Anonymous	Fluoride	0.1 mg/L	<0.1	<0.1	0.0
ES0705218-007	BH5	Fluoride	0.1 mg/L	0.3	0.6	65.2
EK055G: Ammonia as N by Discrete Analyser						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 397085)				mg/L	mg/L	%
ES0705217-001	Anonymous	Ammonia as N	0.010 mg/L	11.7	11.8	1.1
ES0705218-007	BH5	Ammonia as N	0.010 mg/L	0.543	0.597	9.5
EK057G: Nitrite as N by Discrete Analyser						
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 396879)				mg/L	mg/L	%
ES0705218-001	BH9	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
ES0705221-003	Anonymous	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
EK059G: NOX as N by Discrete Analyser						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 397089)				mg/L	mg/L	%
ES0705218-001	BH9	Nitrite + Nitrate as N	0.010 mg/L	0.833	0.850	2.0

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EK059G: NOX as N by Discrete Analyser - continued						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 397089) - continued				**mg/L**	**mg/L**	**%**
ES0705221-003	Anonymous	Nitrite + Nitrate as N	0.010 mg/L	<0.010	<0.010	0.0
EP005: Total Organic Carbon (TOC)						
EP005: Total Organic Carbon (TOC) - (QC Lot: 399506)				**mg/L**	**mg/L**	**%**
ES0705195-004	Anonymous	Total Organic Carbon	1 mg/L	20	20	0.0
ES0705219-002	Anonymous	Total Organic Carbon	1 mg/L	2	2	0.0
EP035G: Total Phenol by Discrete Analyser						
EP035G: Total Phenol by Discrete Analyser - (QC Lot: 398067)				**mg/L**	**mg/L**	**%**
ES0705130-001	Anonymous	Phenols (Total)	0.050 mg/L	<0.050	<0.050	0.0
ES0705218-006	BH4	Phenols (Total)	0.050 mg/L	<0.050	<0.050	0.0
EP074D: Fumigants						
EP074D: Fumigants - (QC Lot: 397425)				**µg/L**	**µg/L**	**%**
ES0705218-001	BH9	2,2-Dichloropropane	5 µg/L	<5	<5	0.0
		1,2-Dichloropropane	5 µg/L	<5	<5	0.0
		cis-1,3-Dichloropropylene	5 µg/L	<5	<5	0.0
		trans-1,3-Dichloropropylene	5 µg/L	<5	<5	0.0
		1,2-Dibromoethane (EDB)	5 µg/L	<5	<5	0.0
EP074E: Halogenated Aliphatic Compounds						
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425)				**µg/L**	**µg/L**	**%**
ES0705218-001	BH9	Dichlorodifluoromethane	50 µg/L	<50	<50	0.0
		Chloromethane	50 µg/L	<50	<50	0.0
		Vinyl chloride	50 µg/L	<50	<50	0.0
		Bromomethane	50 µg/L	<50	<50	0.0
		Chloroethane	50 µg/L	<50	<50	0.0
		Trichlorofluoromethane	50 µg/L	<50	<50	0.0
		1,1-Dichloroethene	5 µg/L	<5	<5	0.0
		Iodomethane	5 µg/L	<5	<5	0.0
		trans-1,2-Dichloroethene	5 µg/L	<5	<5	0.0
		1,1-Dichloroethane	5 µg/L	<5	<5	0.0
		cis-1,2-Dichloroethene	5 µg/L	<5	<5	0.0

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EP074E: Halogenated Aliphatic Compounds - continued						
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425) - continued				µg/L	µg/L	%
ES0705218-001	BH9	1,1,1-Trichloroethane	5 µg/L	<5	<5	0.0
		1,1-Dichloropropylene	5 µg/L	<5	<5	0.0
		Carbon Tetrachloride	5 µg/L	<5	<5	0.0
		1,2-Dichloroethane	5 µg/L	<5	<5	0.0
		Trichloroethene	5 µg/L	<5	<5	0.0
		Dibromomethane	5 µg/L	<5	<5	0.0
		1,1,2-Trichloroethane	5 µg/L	<5	<5	0.0
		1,3-Dichloropropane	5 µg/L	<5	<5	0.0
		Tetrachloroethene	5 µg/L	<5	<5	0.0
		1,1,1,2-Tetrachloroethane	5 µg/L	<5	<5	0.0
		trans-1,4-Dichloro-2-butene	5 µg/L	<5	<5	0.0
		cis-1,4-Dichloro-2-butene	5 µg/L	<5	<5	0.0
		1,1,2,2-Tetrachloroethane	5 µg/L	<5	<5	0.0
		1,2,3-Trichloropropane	5 µg/L	<5	<5	0.0
		Pentachloroethane	5 µg/L	<5	<5	0.0
		1,2-Dibromo-3-chloropropane	5 µg/L	<5	<5	0.0
		Hexachlorobutadiene	5 µg/L	<5	<5	0.0
EP074F: Halogenated Aromatic Compounds						
EP074F: Halogenated Aromatic Compounds - (QC Lot: 397425)				µg/L	µg/L	%
ES0705218-001	BH9	Chlorobenzene	5 µg/L	<5	<5	0.0
		Bromobenzene	5 µg/L	<5	<5	0.0
		2-Chlorotoluene	5 µg/L	<5	<5	0.0
		4-Chlorotoluene	5 µg/L	<5	<5	0.0
		1,3-Dichlorobenzene	5 µg/L	<5	<5	0.0
		1,4-Dichlorobenzene	5 µg/L	<5	<5	0.0
		1,2-Dichlorobenzene	5 µg/L	<5	<5	0.0
		1,2,4-Trichlorobenzene	5 µg/L	<5	<5	0.0
		1,2,3-Trichlorobenzene	5 µg/L	<5	<5	0.0
EP074G: Trihalomethanes						

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EP074G: Trihalomethanes - continued						
EP074G: Trihalomethanes - (QC Lot: 397425)				µg/L	µg/L	%
ES0705218-001	BH9	Chloroform	5 µg/L	6	7	16.4
		Bromodichloromethane	5 µg/L	<5	<5	0.0
		Dibromochloromethane	5 µg/L	<5	<5	0.0
		Bromoform	5 µg/L	<5	<5	0.0

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
				LCS	Low	High
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 399579)		mg/L	mg/L	%	%	%
Total Alkalinity as CaCO3	1 mg/L	----	200	99.5	80.2	108
ED037P: Alkalinity by PC Titrator - (QC Lot: 399581)		mg/L	mg/L	%	%	%
Total Alkalinity as CaCO3	1 mg/L	----	200	99.5	80.2	108
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 396735)		mg/L	mg/L	%	%	%
Sulphate as SO4 2-	1 mg/L	----	150	97.4	82.9	114
	1 mg/L	<1	1	----	----	----
ED045G: Chloride Discrete analyser						
ED045G: Chloride Discrete analyser - (QC Lot: 397082)		mg/L	mg/L	%	%	%
Chloride	1 mg/L	----	50	103	83.7	124
	1 mg/L	----	250	101	83.7	124
	1.0 mg/L	<1.0	----	----	----	----
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 396734)		mg/L	mg/L	%	%	%
Calcium	1 mg/L	----	50	99.6	82.9	121
	1 mg/L	<1	----	----	----	----
Magnesium	1 mg/L	<1	----	----	----	----
	1 mg/L	----	50	95.9	82.7	114
Potassium	1 mg/L	<1	----	----	----	----
	1 mg/L	----	50	96.8	84.3	118
Sodium	1 mg/L	----	50	100	77.4	113
	1 mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS						

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
Analyte name	*LOR*			*LCS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 397312)		mg/L	mg/L	%	%	%
Iron	0.05 mg/L	<0.05	----	----	----	----
	0.05 mg/L	----	0.5	98.2	70	130
Manganese	0.001 mg/L	----	0.1	97.8	70	130
	0.001 mg/L	<0.001	----	----	----	----
EK040P: Fluoride by PC Titrator						
EK040P: Fluoride by PC Titrator - (QC Lot: 399580)		mg/L	mg/L	%	%	%
Fluoride	0.1 mg/L	----	5.0	98.2	64.8	115
	0.1 mg/L	<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 397085)		mg/L	mg/L	%	%	%
Ammonia as N	0.01 mg/L	----	1.00	89.8	75.6	128
	0.010 mg/L	<0.010	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser						
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 396879)		mg/L	mg/L	%	%	%
Nitrite as N	0.01 mg/L	----	0.96	108	66.6	131
	0.010 mg/L	<0.010	----	----	----	----
EK059G: NOX as N by Discrete Analyser						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 397089)		mg/L	mg/L	%	%	%
Nitrite + Nitrate as N	0.010 mg/L	<0.010	----	----	----	----
	0.01 mg/L	----	0.96	99.2	76.9	122
EP005: Total Organic Carbon (TOC)						
EP005: Total Organic Carbon (TOC) - (QC Lot: 399506)		mg/L	mg/L	%	%	%
Total Organic Carbon	1 mg/L	<1	----	----	----	----
	1 mg/L	----	10	92.6	86.9	125
EP035G: Total Phenol by Discrete Analyser						
EP035G: Total Phenol by Discrete Analyser - (QC Lot: 398067)		mg/L	mg/L	%	%	%
Phenols (Total)	0.05 mg/L	----	0.50	96.2	65.6	118
	0.050 mg/L	<0.050	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
				LCS	Low	High
EP074D: Fumigants						
EP074D: Fumigants - (QC Lot: 397425)		µg/L	µg/L	%	%	%
1,2-Dibromoethane (EDB)	5 µg/L	----	10	100	79.1	123
	5 µg/L	<5	----	----	----	----
1,2-Dichloropropane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	80.7	119
2,2-Dichloropropane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	99.3	72.7	124
cis-1,3-Dichloropropylene	5 µg/L	----	20	103	80.4	119
	5 µg/L	<5	----	----	----	----
trans-1,3-Dichloropropylene	5 µg/L	----	20	98.7	79.3	120
	5 µg/L	<5	----	----	----	----
EP074E: Halogenated Aliphatic Compounds						
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425)		µg/L	µg/L	%	%	%
1,1,1,2-Tetrachloroethane	5 µg/L	----	10	106	78.9	121
	5 µg/L	<5	----	----	----	----
1,1,1-Trichloroethane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	102	75.8	124
1,1,2,2-Tetrachloroethane	5 µg/L	----	10	105	77.8	126
	5 µg/L	<5	----	----	----	----
1,1,2-Trichloroethane	5 µg/L	----	10	101	79.6	122
	5 µg/L	<5	----	----	----	----
1,1-Dichloroethane	5 µg/L	----	10	102	79.3	121
	5 µg/L	<5	----	----	----	----
1,1-Dichloroethene	5 µg/L	----	10	98.5	72.5	128
	5 µg/L	<5	----	----	----	----
1,1-Dichloropropylene	5 µg/L	----	10	104	77.8	121
	5 µg/L	<5	----	----	----	----
1,2,3-Trichloropropane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	96.9	74.1	128
1,2-Dibromo-3-chloropropane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	66.4	136

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EP074E: Halogenated Aliphatic Compounds - continued						
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425) - continued		µg/L	µg/L	%	%	%
1,2-Dichloroethane	5 µg/L	----	10	104	75.5	126
	5 µg/L	<5	----	----	----	----
1,3-Dichloropropane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	104	79.9	122
Bromomethane	50 µg/L	<50	----	----	----	----
	50 µg/L	----	100	106	68.9	131
Carbon Tetrachloride	5 µg/L	----	10	105	73.8	126
	5 µg/L	<5	----	----	----	----
Chloroethane	50 µg/L	----	100	101	73.9	126
	50 µg/L	<50	----	----	----	----
Chloromethane	50 µg/L	----	100	94.9	67.4	130
	50 µg/L	<50	----	----	----	----
cis-1,2-Dichloroethene	5 µg/L	----	10	105	79.5	121
	5 µg/L	<5	----	----	----	----
cis-1,4-Dichloro-2-butene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	70.6	128
Dibromomethane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	76.1	126
Dichlorodifluoromethane	50 µg/L	<50	----	----	----	----
	50 µg/L	----	100	91.6	60.6	138
Hexachlorobutadiene	5 µg/L	----	10	112	67.2	129
	5 µg/L	<5	----	----	----	----
Iodomethane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	113	70.2	128
Pentachloroethane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	109	71.8	126
Tetrachloroethene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	100	75	124
trans-1,2-Dichloroethene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	77.4	122

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
EP074E: Halogenated Aliphatic Compounds - continued						
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425) - continued		µg/L	µg/L	%	%	%
trans-1,4-Dichloro-2-butene	5 µg/L	----	10	90.8	61.4	136
	5 µg/L	<5	----	----	----	----
Trichloroethene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	106	76.7	123
Trichlorofluoromethane	50 µg/L	----	100	103	71.6	128
	50 µg/L	<50	----	----	----	----
Vinyl chloride	50 µg/L	<50	----	----	----	----
	50 µg/L	----	100	99.7	69.4	129
EP074F: Halogenated Aromatic Compounds						
EP074F: Halogenated Aromatic Compounds - (QC Lot: 397425)		µg/L	µg/L	%	%	%
1,2,3-Trichlorobenzene	5 µg/L	----	10	108	68.6	128
	5 µg/L	<5	----	----	----	----
1,2,4-Trichlorobenzene	5 µg/L	----	10	102	67.8	129
	5 µg/L	<5	----	----	----	----
1,2-Dichlorobenzene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	105	82.3	116
1,3-Dichlorobenzene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	78.9	120
1,4-Dichlorobenzene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	103	79.9	119
2-Chlorotoluene	5 µg/L	----	10	102	78.2	120
	5 µg/L	<5	----	----	----	----
4-Chlorotoluene	5 µg/L	----	10	104	79	119
	5 µg/L	<5	----	----	----	----
Bromobenzene	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	95.6	79.3	119
Chlorobenzene	5 µg/L	----	10	102	80.8	119
	5 µg/L	<5	----	----	----	----
EP074G: Trihalomethanes						

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
EP074G: Trihalomethanes - continued						
EP074G: Trihalomethanes - (QC Lot: 397425)		µg/L	µg/L	%	%	%
Bromodichloromethane	5 µg/L	----	10	107	76.9	123
	5 µg/L	<5	----	----	----	----
Bromoform	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	108	73.5	126
Chloroform	5 µg/L	----	10	100	78.2	122
	5 µg/L	<5	----	----	----	----
Dibromochloromethane	5 µg/L	<5	----	----	----	----
	5 µg/L	----	10	107	78.5	124

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: **LOR** = Limit of Reporting, **RPD** = Relative Percent Difference.*

* Indicates failed QC

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		*Recovery Limits*	
					Sample Result	*Spike Recovery*	*Static Limits*	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
ED045G: Chloride Discrete analyser								
ED045G: Chloride Discrete analyser - (QC Lot: 397082)				mg/L	mg/L	%	%	%
Chloride	ES0705217-001	Anonymous	1 mg/L	250	31.4	104	70	130
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 397312)				mg/L	mg/L	%	%	%
Manganese	EP0701582-001	Anonymous	0.001 mg/L	0.2	0.144	89.8	70	130
EK040P: Fluoride by PC Titrator								
EK040P: Fluoride by PC Titrator - (QC Lot: 399580)				mg/L	mg/L	%	%	%
Fluoride	ES0705218-002	BH10	0.1 mg/L	5.0	0.1	99.0	70	130
EK055G: Ammonia as N by Discrete Analyser								
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 397085)				mg/L	mg/L	%	%	%
Ammonia as N	ES0705217-001	Anonymous	0.01 mg/L	1.00	11.7	* Not Determined	70	130
EK057G: Nitrite as N by Discrete Analyser								
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 396879)				mg/L	mg/L	%	%	%
Nitrite as N	ES0705218-001	BH9	0.01 mg/L	0.60	<0.010	106	70	130
EK059G: NOX as N by Discrete Analyser								
EK059G: NOX as N by Discrete Analyser - (QC Lot: 397089)				mg/L	mg/L	%	%	%
Nitrite + Nitrate as N	ES0705218-001	BH9	0.01 mg/L	0.60	0.833	74.5	70	130
EP005: Total Organic Carbon (TOC)								
EP005: Total Organic Carbon (TOC) - (QC Lot: 399506)				mg/L	mg/L	%	%	%
Total Organic Carbon	ES0705207-001	Anonymous	1 mg/L	100	5	110	70	130
EP035G: Total Phenol by Discrete Analyser								
EP035G: Total Phenol by Discrete Analyser - (QC Lot: 398067)				mg/L	mg/L	%	%	%
Phenols (Total)	ES0705130-001	Anonymous	0.05 mg/L	0.42	<0.050	98.1	70	130

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		*Recovery Limits*	
					Sample Result	*Spike Recovery*	*Static Limits*	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP074E: Halogenated Aliphatic Compounds								
EP074E: Halogenated Aliphatic Compounds - (QC Lot: 397425)				µg/L	µg/L	%	%	%
1,1-Dichloroethene	ES0705218-001	BH9	5 µg/L	25	<5	131	70	130
Trichloroethene			5 µg/L	25	<5	120	70	130
EP074F: Halogenated Aromatic Compounds								
EP074F: Halogenated Aromatic Compounds - (QC Lot: 397425)				µg/L	µg/L	%	%	%
Chlorobenzene	ES0705218-001	BH9	5 µg/L	25	<5	113	70	130

AUSTRALIAN LABORATORY SERVICES PTY LTD ABN 84 009 936 029
277-289 Woodpark Road Smithfield NSW 2164 Australia
Telephone: 61-2-8784 8555 Facsimile: 61-2-8784 8500 http://www.alsenviro.com/

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive report

Client Details		*Laboratory Details*	
Client	: **ROBERT CARR & ASSOCIATES P/L**	Laboratory	: **Environmental Division Sydney**
Contact	: **MR CRAIG WELLINGS**	Manager	: **Victor Kedicioglu**
Address	: P O BOX 175 CARRINGTON NSW AUSTRALIA 2294	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Project	: **5929**	Quote number	: ----
Order number	: **- Not provided -**	Work order	: **ES0705218**
C-O-C Number	: **202536**		
Site	: **- Not provided -**		
Sampler	: **CRAIG WELLINGS**		
E-mail	: craigw@rca.com.au	E-mail	: Victor.Kedicioglu@alsenviro.com
Telephone	: 49029200	Telephone	: 61-2-8784 8555
Facsimile	: 49029299	Facsimile	: 61-2-8784 8500

Dates

Date Samples Received	: 23 Apr 2007	SRA Issue Date	: 24 Apr 2007
Scheduled Reporting Date	: **1 May 2007**	Client Requested Date	: 1 May 2007

Delivery Details

Mode of Delivery	: Carrier.	Temperature		: CHILLED - Ice bricks present
No. of coolers/boxes	: 2 HARD	No. of samples	- Received	7
Security Seal	: Intact.		- Analysed	7

Comments

- **Samples received in appropriately pretreated and preserved containers.**
- **pH analysis should be conducted within 6 hours of sampling.**
- **Breaches in recommended extraction / analysis holding times may occur. Please contact ALSE for further information (Nanthini Coilparampil).**
- **NO3 should be analysed within 48 hours of sampling.**

- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Nanthini Coilparampil
- Analytical work for this work order will be conducted at ALSE Sydney.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.
- When the sampling time is not supplied on the COC documentation, ALSE defaults the sampling time to that of the COC 'relinquishment' time (if supplied). If this also is not supplied, ALSE defaults the sampling time to the 'time of receipt at Laboratory'.

Client : ROBERT CARR & ASSOCIATES P/L
Work Order : ES0705218
Project : 5929
ALS Quote Reference : ----

Summary of Sample(s) / Container(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as moisture and preparation tasks, that form an implicit part of that package.

ALS Sample ID.	Client Sample ID - Sample Date	**Requested Analysis**									
		EA005: pH - WATER pH	**ED037P - WATER** Total Alkalinity as CaCO3 (PC)	**ED040F - WATER** Dissolved Major Anions	**ED045G - WATER** Chloride by Discrete Analyser	**ED093F - WATER** Dissolved Major Cations	**EG020A-F - WATER** Dissolved Metals by ICPMS - Suite A	**EK040-P - WATER** Fluoride(PC)	**EK055G - WATER** Ammonia as N By Discrete Analyser	**EK058G - WATER** Nitrate as N by Discrete Analyser	**EN055 - DA - WATER** Ionic Balance (DA)
ES0705218-001	**BH9 - 18 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-002	**BH10 - 19 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-003	**BH11 - 19 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-004	**BH12 - 19 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-005	**BH13 - 19 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-006	**BH4 - 20 Apr 2007**	●	●	●	●	●	●	●	●	●	●
ES0705218-007	**BH5 - 20 Apr 2007**	●	●	●	●	●	●	●	●	●	●
	Total(s) :	7	7	7	7	7	7	7	7	7	7

SAMPLE RECEIPT NOTIFICATION (SRN) - continued

Client : ROBERT CARR & ASSOCIATES P/L
Project : 5929

Work Order : ES0705218
ALS Quote Reference : ----

ALS Sample ID.	Client Sample ID - Sample Date	**Requested Analysis**									
		EP005 - WATER Total Organic Carbon (TOC)	**EP035G - WATER** Total Phenol by Discrete Analyser	**EP074DEFG - WATER** VOC - Fumigants, Hal Aliphatics, Hal Aromatics, THM							
ES0705218-001	**BH9 - 18 Apr 2007**	●	●	●							
ES0705218-002	**BH10 - 19 Apr 2007**	●	●	●							
ES0705218-003	**BH11 - 19 Apr 2007**	●	●	●							
ES0705218-004	**BH12 - 19 Apr 2007**	●	●	●							
ES0705218-005	**BH13 - 19 Apr 2007**	●	●	●							
ES0705218-006	**BH4 - 20 Apr 2007**	●	●	●							
ES0705218-007	**BH5 - 20 Apr 2007**	●	●	●							
	Total(s) :	**7**	**7**	**7**							

Requested Reports

- **MR CRAIG WELLINGS**

- A4 - AU Certificate of Analysis - NEPM format	Email	craigw@rca.com.au
- A4 - AU Quality Control Report - NEPM format	Email	craigw@rca.com.au
- A4 - AU Interpretive Quality Control Report - NEPM format	Email	craigw@rca.com.au
- EDI Format - ENMRG	Email	craigw@rca.com.au
- Default - Chain of Custody	Email	craigw@rca.com.au
- A4 - AU Sample Receipt Notification - Comprehensive format	Email	craigw@rca.com.au

- **MS DANIELLE WHITE**

- A4 - AU Certificate of Analysis - NEPM format	Email	daniellew@rca.com.au
- A4 - AU Quality Control Report - NEPM format	Email	daniellew@rca.com.au
- A4 - AU Interpretive Quality Control Report - NEPM format	Email	daniellew@rca.com.au
- EDI Format - ENMRG	Email	daniellew@rca.com.au
- Default - Chain of Custody	Email	daniellew@rca.com.au
- A4 - AU Sample Receipt Notification - Comprehensive format	Email	daniellew@rca.com.au
- A4 - AU Tax Invoice	Email	daniellew@rca.com.au

Sample Container(s) / Preservation Non-Compliance Log

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

CHAIN OF CUSTODY DOCUMENTATION

202536

ALS Laboratory Group

CLIENT: RCA Australia		SAMPLER: Craig Wellings	
ADDRESS / OFFICE: PO Box 175 Carrington 2294		MOBILE: 0412672805	
PROJECT MANAGER (PM): Craig Wellings		PHONE 49029212	
PROJECT ID: 5929		EMAIL REPORT TO: craigw@rca.com.au	
SITE:	P.O. NO.:	EMAIL INVOICE TO: (if different to report) same	
RESULTS REQUIRED (Date):	QUOTE NO.:		

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: [✓ Yes] No N/A
SAMPLE TEMPERATURE
CHILLED: Yes [✓ No]

COMMENTS / SPECIAL HANDLING / STORAGE OR DIPOSAL:

ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

Notes: e.g. Highly contaminated samples e.g. "High PAHs expected". Extra volume for QC or trace LORs etc.

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION															
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles	pH	Total Alkalinity	Dissolved Major Anions	Dissolved Major Cations	Ion Balance	Chloride	Fluoride	Nitrate	Ammonia	Dissolved Metals *	TOC	Total Phenolics	VHCs	Notes
①	BH9	W	18/4/07				x	x	x	x	x	x	x	x	x	x	x	x	x	* Fe, Mg, Mn
②	BH10	"	19/4/07				x	x	x	x	x	x	x	x	x	x	x	x	x	
③	BH11	"	"				x	x	x	x	x	x	x	x	x	x	x	x	x	Note: all TOC samples
④	BH12	"	"				x	x	x	x	x	x	x	x	x	x	x	x	x	field filtered (0.45μm)
⑤	BH13	"	"				x	x	x	x	x	x	x	x	x	x	x	x	x	
⑥	BH4	"	20/4/07				x	x	x	x	x	x	x	x	x	x	x	x	x	
⑦	BH5	"	"				x	x	x	x	x	x	x	x	x	x	x	x	x	

Environmental Division
Sydney
Work Order
ES0705218
Telephone : 61-2-8784 8555

RELINQUISHED BY:		RECEIVED BY		
Name: Craig Wellings	Date: 23/4/07	Name: Hayley Northington	Date: 23/4/07	
Of: RCA Australia	Time:	Of: ALS Newcastle	Time: 11:00	
Name: Hayley Northington	Date: 23/4/07	Name: JESSIE	Date: 24-4-07	Transport Co:
Of: ALS Newcastle	Time: 4pm	Of: ALS Syd	Time: 8:30a.m.	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserveed Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Laboratory Group

WHITE - LAB COPY
YELLOW - CUSTOMER COPY
PINK - BOOK COPY

COC Page 1 of 1

Appendix E

Field Permeability Test Results

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PIEZOMETER TEST

CLIENT:	Maunsell Australia Pty Ltd	**DATE:**	21/05/2007
PROJECT:	Groundwater Assessment	**RCA ref:**	5929
LOCATION:	Proposed Landfill - Armidale	**CLIENT REF:**	

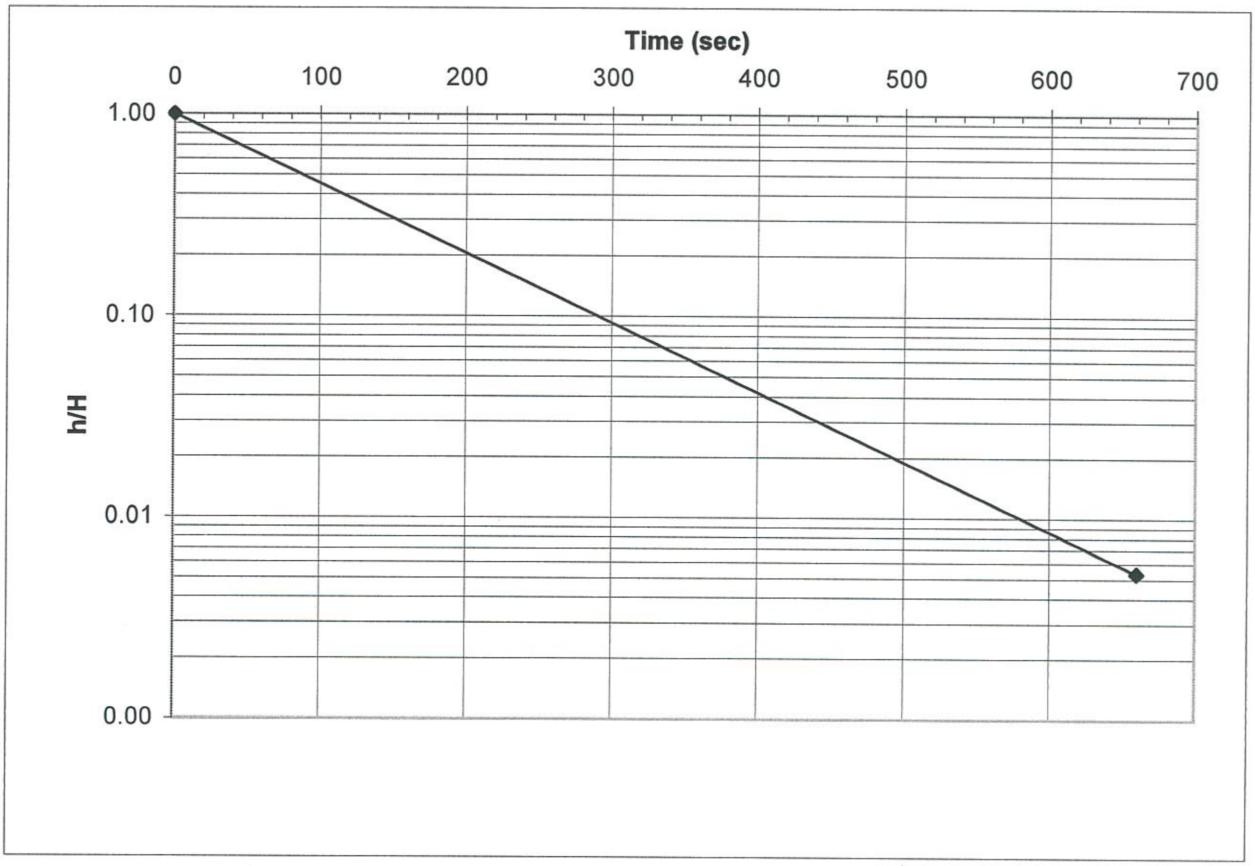
BORE DETAILS

Bore No.	BH11
Piezometer length (L)	6 m
Piezometer radius (r)	0.025 m
Bore radius (R)	0.075 m
Depth of piezometer	36 m
Static water level	28.02 m
Lag time T_o (37% recovery)	60 sec

Results

Time (sec)	Depth to water (m)	Change in level (m)	h/H
Static	28.02		
0	22.39	-5.63	1.00
660	27.99	-0.03	0.01

TEST METHOD: Falling head



Based on Hvorslev method

$$K = \frac{r^2 \ln(L/R)}{2LT_o}$$

Calculated Permeability **3.8E-06 m / sec**

RCA Australia	**Tested by: CW**	**Date: 17/4/07**
Office:	**Checked by: MA**	**Date: 22/5/07**

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PIEZOMETER TEST

CLIENT:	Maunsell Australia Pty Ltd	**DATE:**	21/05/2007
PROJECT:	Groundwater Assessment	**RCA ref:**	5929
LOCATION:	Proposed Landfill - Armidale	**CLIENT REF:**	

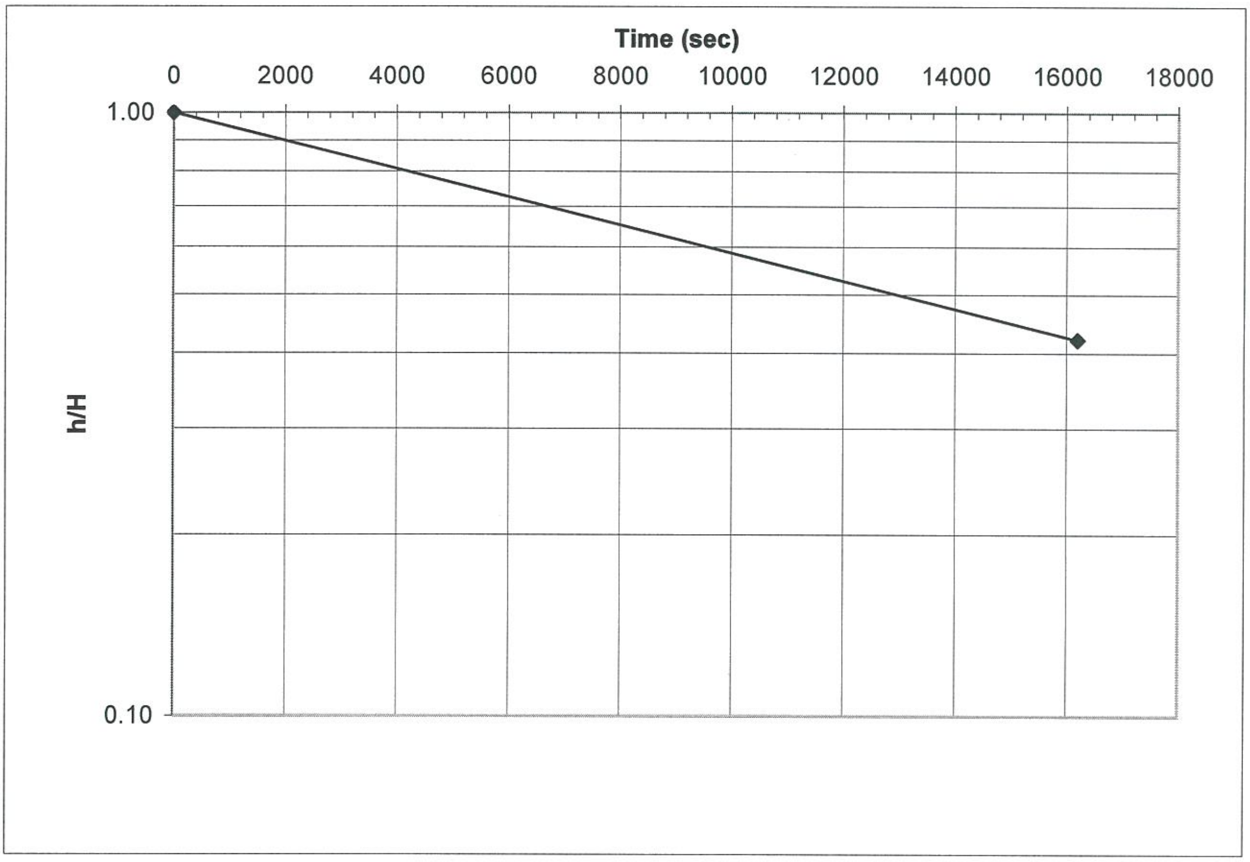
BORE DETAILS

Bore No.	BH5
Piezometer length (L)	3 m
Piezometer radius (r)	0.025 m
Bore radius (R)	0.075 m
Depth of piezometer	10.33 m
Static water level	5.27 m
Lag time T_o (37% recovery)	8800 sec

Results

Time (sec)	Depth to water (m)	Change in level (m)	h/H
Static	5.27		
0	10.33	5.06	1.00
16200	7.40	2.13	0.42

TEST METHOD: Rising head



Based on Hvorslev method

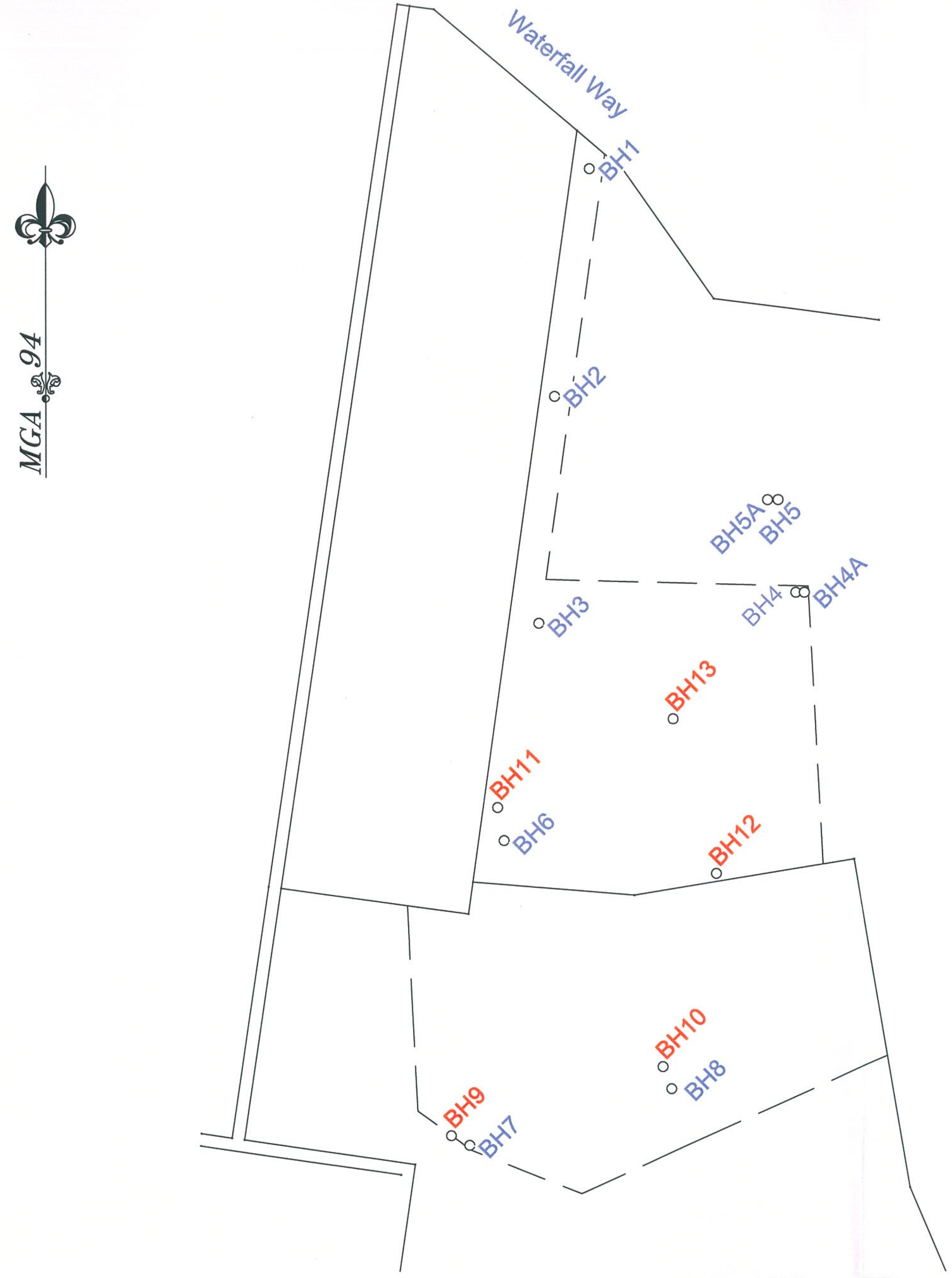
$$K = \frac{r^2 \ln(L/R)}{2LT_o}$$

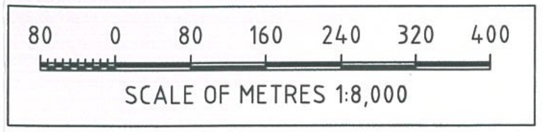
Calculated Permeability **4.4E-08 m / sec**

RCA Australia	**Tested by: CW**	**Date: 20/4/07**
Office:	**Checked by: MA**	**Date: 22/5/07**

Appendix F

Survey Results





MARK	Easting	Northing	Height
BH1	383353.47	6620262.81	980.48
BH2	383297.43	6619894.91	958.14
BH3	383271.88	6619528.24	962.85
BH6	383215.21	6619176.42	981.14
BH7	383158.60	6618681.95	1010.58
BH8	383484.77	6618773.13	999.37
BH4	383691.47	6619577.55	954.11
BH4A	383693.19	6619577.72	953.96
BH5A	383649.85	6619727.47	953.05
BH5	383650.96	6619727.59	953.13
BH9	383128.77	6618697.86	1014.03
BH10	383470.84	6618809.06	993.78
BH11	383204.64	6619230.01	977.58
BH12	383558.08	6619122.94	969.79
BH13	383488.09	6619373.36	961.70

Notes:
1. Coordinates are in Map Grid of Australia, Zone 56 (MGA 94 / 56)
2. Heights are on the Australian Height Datum (AHD)
3. Heights for Monitoring Wells relate to the highest point of the PVC pipe (after removing the cap)
4. Survey conducted on Thursday 10-05-2007
5. Proposed Landfill Boundary is indicative only

Revision	Date	Description
A.	18/5/07	Issued to RCA

THIS SURVEY IS NOT A "SURVEY" AS DEFINED BY THE SURVEYORS ACT 1929. IF ANY CONSTRUCTION IS PLANNED IT WOULD BE ADVISABLE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

ELECTRONIC DATA NOTE:

THE HARD COPIES OF THESE PLANS ARE THOSE TO WHICH WE CERTIFY TO BE CORRECT. THE ADDITIONAL ELECTRONIC DATA SUPPLIED IS SUPPLIED ON A "USER BEWARE " BASIS. HAWKINS HOOK & Co. HOLDS ORIGINAL DATA FOR VERIFICATION.

Project:

Proposed Armidale Dumaresq Landfill Site - Waterfall Way (MR76), Armidale NSW

Drawing Title

Borehole & Test Pit Locations

Client:

RCA Australia
PO Box 175
92 Hill Street
Carrington N.S.W. 2294

Hawkins Hook & C°.
Consulting Surveyors & Planners
"Surveying the New England & Planning for our Future"
27 Marsh Street Armidale NSW, 2350
Ph: (02) 6772 3141 Fax: (02) 6771 3858
e-mail: hawkhook@optusnet.com.au

Scale: 1 : 8,000
Cad Scale Factor: x1.0
Backup Disk No: hh5
Cad File Name: 20070410
Datum: A.H.D.
PM 34119 RL 962.399
Surveyors Reference: GARA/56/1
Date: 15th, May 2007
Drawn: R.D.
Surveyed: R.D. A.B.
Sheet 1 of 1
Revision: A
A3

Appendix G

Water Sample Field Sheets

RCA
AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

ENGINEERING FIELD SHEET

WATER SAMPLING RECORD

CLIENT:

DATE: 18/4/07

PROJECT: Groundwater Monitoring

PROJECT No: 5929

LOCATION: Proposed Landfill Site – Armidale.

CLIENT REF: –

WATER METER USED: Horiba U10

DATE & TYPE OF LAST CALIBRATION (1PT OR FULL): 1pt on each day sampling

METHOD OF SAMPLING: Bennett deep sampling pump

PRESERVATION & STORAGE (TICK): Field Temp ☐ Chilled (<4°C) ☑ Frozen ☐

Un-preserved ☐ Preserved: ☐ Acid (H_2SO_4) ☐ Acid (HNO_3) ☐ Alkaline (NaOH) ☐ Filtered ☐

TESTS REQUIRED:

OTHER DETAILS:

BORE OR LOCATION ID: BH9

TIME: TO

BORE DEPTH:

HEIGHT ABOVE GROUND LEVEL: 0.95 (raised 0.52)

DEPTH TO AQUIFER: 46.2m (46.7m)

VOLUME PURGED: >100L

RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O_2)	Temperature (°C)	Salinity (%)
1/	7.59	1.26	38	6.53	19.3	0.05
2/	7.63	1.26	31	6.33	20.3	0.05
3/						
4/						
5/						
6/						

Sample Appearance: Clear – No odour

Duplicate/Equipment Wash Identification and Other Remarks:

BORE OR LOCATION ID: BH10

TIME: TO

BORE DEPTH:

HEIGHT ABOVE GROUND LEVEL: 0.67

DEPTH TO AQUIFER: 37.0m

VOLUME PURGED: >100L

RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O_2)	Temperature (°C)	Salinity (%)
1/	7.63	3.46	92	5.04	17.8	0.17
2/	7.63	3.43	74	5.95	17.7	0.17
3/						
4/						
5/						
6/						

Sample Appearance: Clear. No odour

Duplicate/Equipment Wash Identification and Other Remarks:

RCA Australia	**Sampled by:** CW	**Date:**
Office:		

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No 5929
DATE 19/4/07

BORE OR LOCATION ID: BH11
TIME: TO
BORE DEPTH:
HEIGHT ABOVE GROUND LEVEL: 0·72 (raised 0·32)
DEPTH TO AQUIFER: 27·70m (28.02m)
VOLUME PURGED: >100L
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O_2)	Temperature (°C)	Salinity (%)
1/	7·74	1·23	152	5·61	18·6	0·05
2/	7·71	1·18	144	5·21	18·6	0·05
3/						
4/						
5/						
6/						

Sample Appearance: Clear – slightly turbid – no odour
Duplicate/Equipment Wash Identification and Other Remarks:

Max pump rate 12 min / 40L   Falling head – 40L introduced; 660 sec to 3cm recovery.

BORE OR LOCATION ID: BH12
TIME: TO
BORE DEPTH:
HEIGHT ABOVE GROUND LEVEL: 0·62
DEPTH TO AQUIFER: 21·32m
VOLUME PURGED: >100L
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O_2)	Temperature (°C)	Salinity (%)
1/	7·58	1·32	89	2·32	19·1	0·06
2/	7·54	1·32	30	1·89	18·8	0·06
3/						
4/						
5/						
6/						

Sample Appearance: Clear – no odour
Duplicate/Equipment Wash Identification and Other Remarks:

BORE OR LOCATION ID: BH13
TIME: TO
BORE DEPTH:
HEIGHT ABOVE GROUND LEVEL: 0·60
DEPTH TO AQUIFER: 13-32m
VOLUME PURGED: >100L
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O_2)	Temperature (°C)	Salinity (%)
1/	7·65	1·33	111	2·94	17·6	0·06
2/	7·71	1·32	110	3·35	17·5	0·06
3/						
4/						
5/						
6/						

Sample Appearance: Clear – slightly turbid. No odour
Duplicate/Equipment Wash Identification and Other Remarks:

PROJECT No 5929
DATE 20/4/07

BORE OR LOCATION ID: BH4
TIME: TO
BORE DEPTH: 18.70
HEIGHT ABOVE GROUND LEVEL: 0.72
DEPTH TO AQUIFER: 6.35
VOLUME PURGED: > 100L
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O₂)	Temperature (°C)	Salinity (%)
1/	7.64	1.68	630	1.08	17.9	0.08
2/	7.61	1.67	535	0.55	17.9	0.07
3/						
4/						
5/						
6/						

Sample Appearance: Mod turbid. No odour,
Duplicate/Equipment Wash Identification and Other Remarks:

BORE OR LOCATION ID: BH5
TIME: TO
BORE DEPTH: 10.33
HEIGHT ABOVE GROUND LEVEL: 0.82
DEPTH TO AQUIFER: 5.27
VOLUME PURGED: Bore Purged dry after removal ≈ 30L
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O₂)	Temperature (°C)	Salinity (%)
1/	~~8.81~~ 7.76	4.68	585	0.76	20.1	0.25
2/	insufficient recovery to allow further readings.					
3/						
4/						
5/						
6/						

Sample Appearance: Mod turbid, No odour -
Duplicate/Equipment Wash Identification and Other Remarks:

Bore empty 12:45 pm (10.33m) target 6.3m = 80%. 7.40 @ 5:15pm

BORE OR LOCATION ID:
TIME: TO
BORE DEPTH:
HEIGHT ABOVE GROUND LEVEL:
DEPTH TO AQUIFER:
VOLUME PURGED:
RESULTS OF WATER QUALITY CHECK:

Check No.	pH	Conductivity (mS/cm)	Turbidity	Dissolved (O₂)	Temperature (°C)	Salinity (%)
1/						
2/						
3/						
4/						
5/						
6/						

Sample Appearance:
Duplicate/Equipment Wash Identification and Other Remarks:

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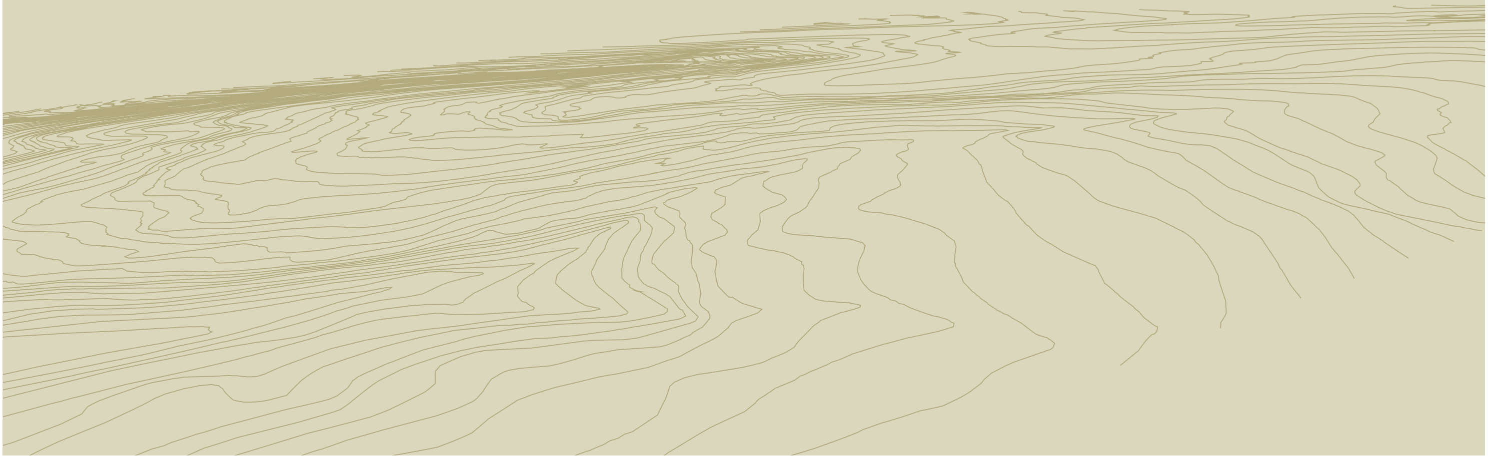
Appendix G

AECOM, 2010: Landfill Concept Design Drawings

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



Cad ref: C:\Working\Detail\20017605-CI-100.dwg   Last modified: 23 Dec 09 - 13:58

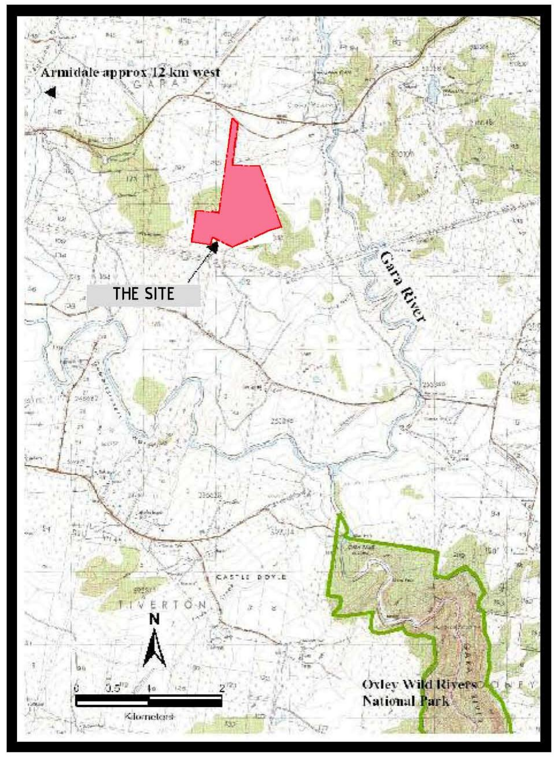
CLIENT:

DESIGNER:

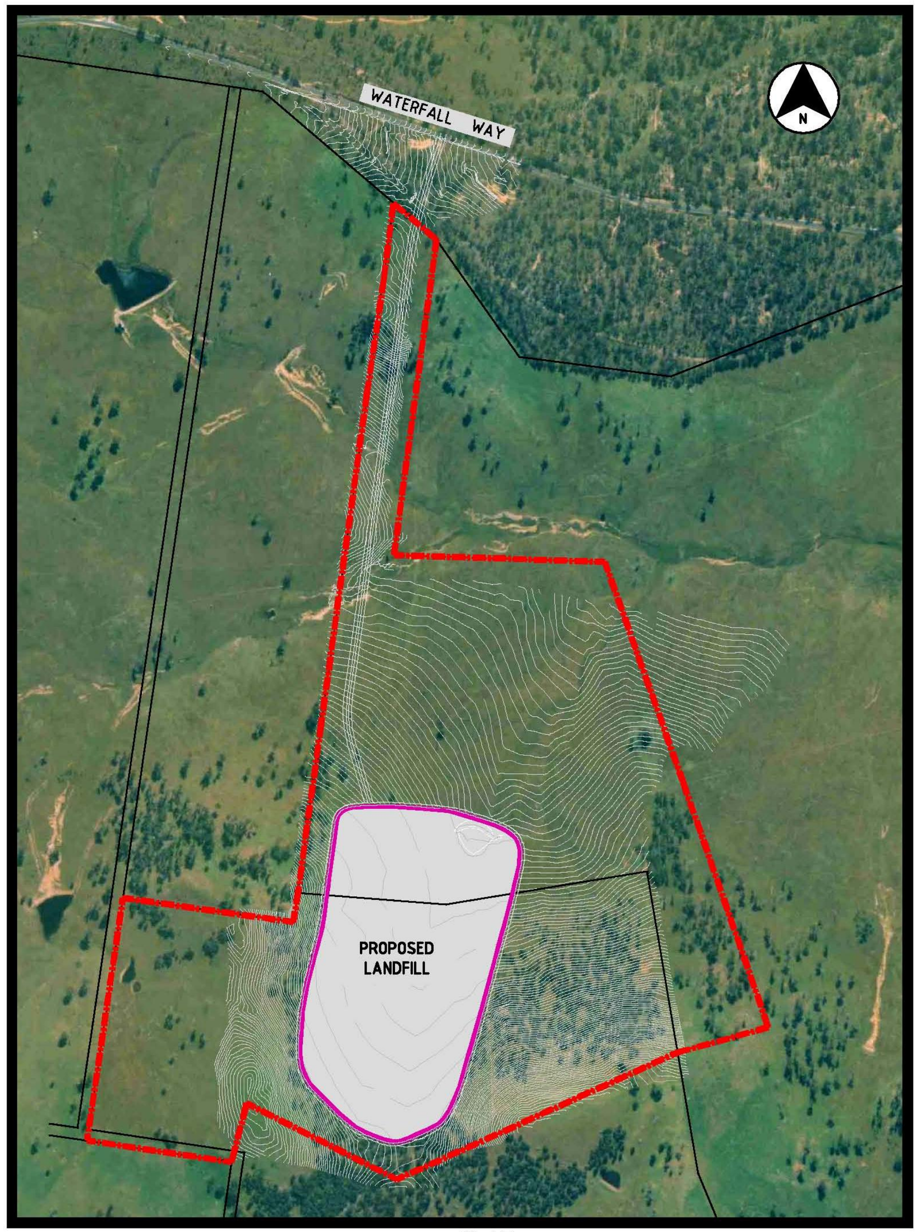
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL

DESIGN AND WATER MANAGEMENT DRAWINGS



LOCALITY PLAN



PLAN

SCALE 1:5000 (A1)

DRAWING LIST

DRAWING No.	DRAWING TITLE
20017605-CI-100	DRAWING LIST AND LOCALITY PLAN
20017605-CI-101	SITE LAYOUT PLAN
20017605-CI-102	LANDFILL FOOTPRINT
20017605-CI-103	LANDFILL SECTIONS
20017605-CI-110	STAGE 1 WATER MANAGEMENT PLAN
20017605-CI-111	STAGE 2 WATER MANAGEMENT PLAN
20017605-CI-112	STAGE 3 WATER MANAGEMENT PLAN
20017605-CI-113	STAGE 4 WATER MANAGEMENT PLAN
20017605-CI-114	STAGE 5 WATER MANAGEMENT PLAN
20017605-CI-120	TYPICAL DRAIN DETAILS AND SECTIONS
20017605-CI-121	TYPICAL DETAILS
20017605-CI-130	LEACHATE POND, SEDIMENTATION BASIN AND DRY BASIN SECTIONS

NOTES:

1. CO-ORDINATES ARE TO MAP GRID OF AUSTRALAIN 1994 ON M.G.A.
2. LEVELS ARE IN METRES WITH RESPECT TO THE AUSTRALIAN HEIGHT DATUM (AHD).
3. ALL DIMENSIONS ARE IN MILLIMETRES UNO.

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No.	BY	DATE	DESCRIPTION	APPD
D	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
C	TT	16.06.08	FINAL ISSUE	AK
B	TT	15.05.08	FINAL FOR REPORT BONDARY REVISED	AK
A	TT	05.05.08	FINAL FOR REPORT	AK

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 100 200 250m
1:10000 (A3)   1:5000 (A1)

CLIENT:

CONTRACTOR:

DESIGNER:

RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

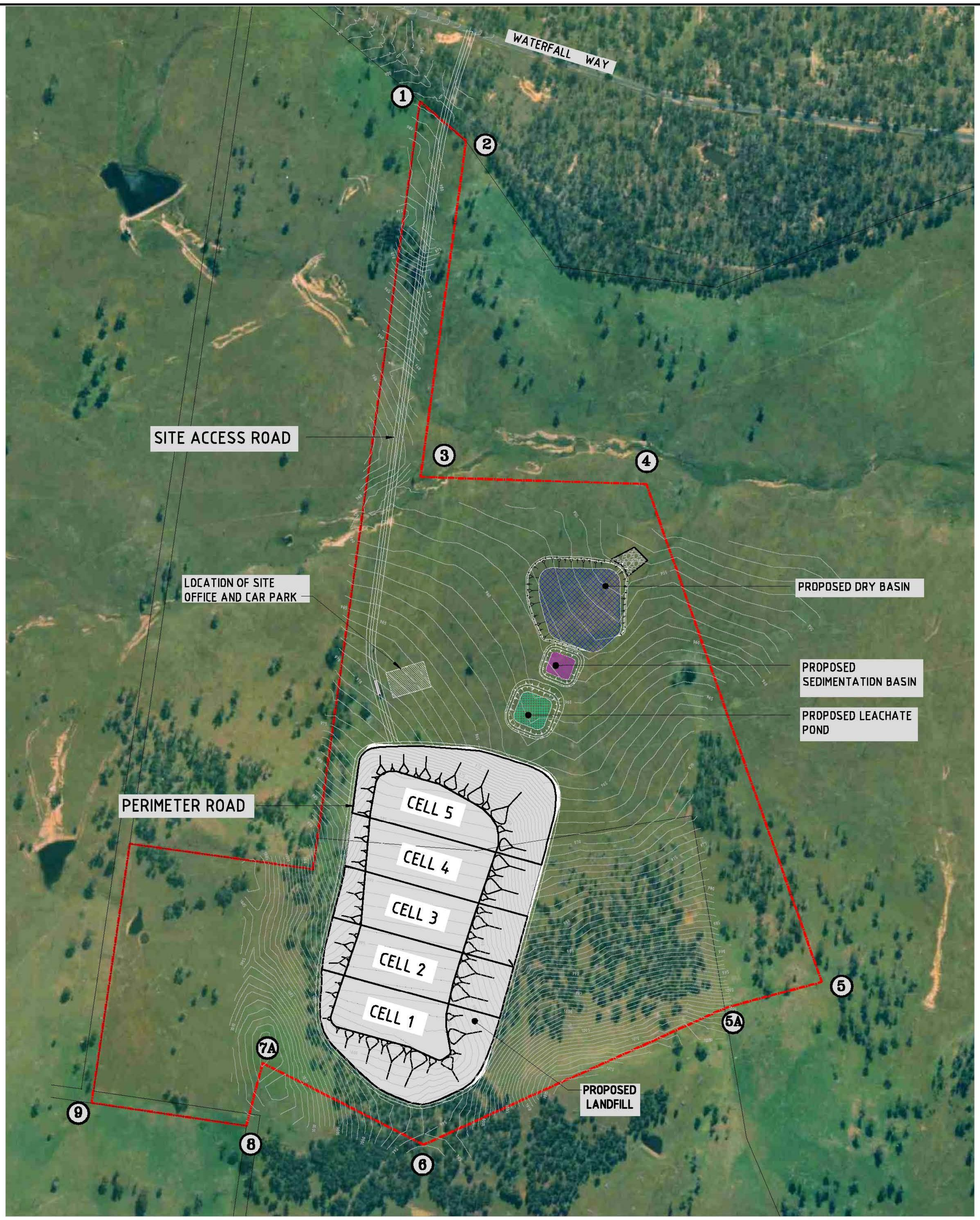
ARMIDALE LANDFILL
DRAWING LIST AND LOCALITY PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-100
REV: D

Cad ref: C:\Working\Detail\20017605-CI-101.dwg Last modified: 23 Dec 09 - 13:58

REFERENCE POINTS

POINT	EASTING	NORTHING
1	383333	6620325
2	383409	6620260
3	383334	6619705
4	383706	6619693
5	383995	6618872
5A	383837	6618829
6	383339	6618603
7A	383068	6618713
8	383047	6618634
9	382792	6618672



This drawing is confidential and shall only be used for the purposes of this project.

No.	BY	DATE	DESCRIPTION	APPD
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C	TT	16.06.08	FINAL ISSUE	AK
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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 40 80 120 160 200m
1:8000 (A3) 1:4000 (A1)

CLIENT:
ARMIDALE DUMARESQ COUNCIL
Building the Future

CONTRACTOR:

DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
SITE LAYOUT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-101
REV: D

Cad ref: C:\Working\Detail\20017605-CI-102.dwg Last modified: 23 Dec 09 - 13:57

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A	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
No.	BY	DATE	DESCRIPTION	APPD

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DESIGNED	AK	CHECKED	
DRAWN	AC	CHECKED	PM
APPROVED	JP	DATE	23.12.09

SCALES:

0 20 40 60 80 100m

1:4000 (A3) 1:2000 (A1)

CLIENT:

CONTRACTOR:

DESIGNER:

AECOM

RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL

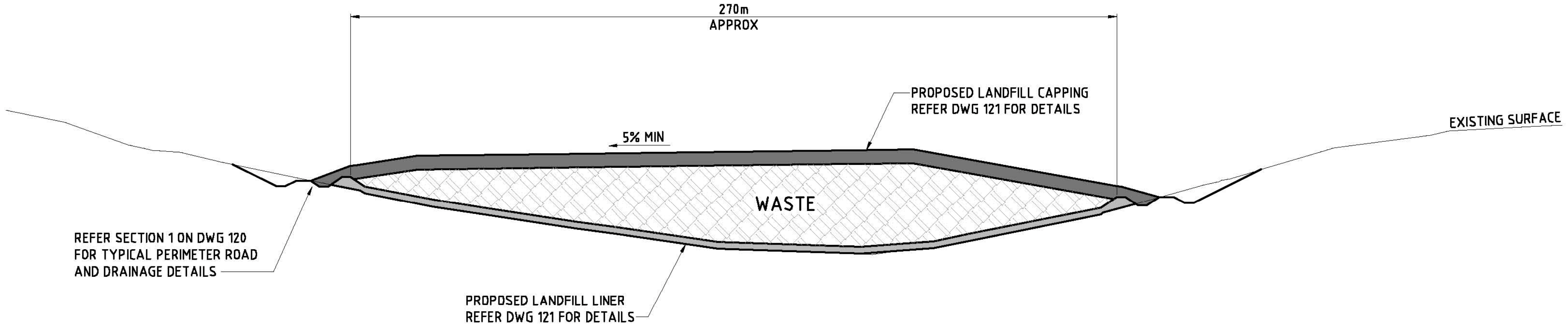
LANDFILL FOOTPRINT

STATUS: DETAILED CONCEPT

DRAWING NO: 20017605-CI-102

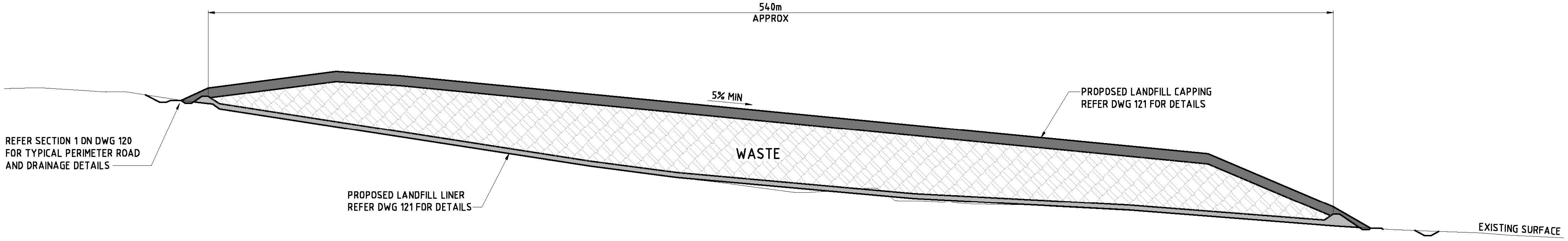
REV: A

Cad ref: C:\Working\Detail\20017605-CI-103.dwg Last modified: 23 Dec 09 - 11:16



SECTION 2 / CI-102

1:1000 HORIZ (A1)
1:500 VERT (A1)



SECTION 1 / CI-102

1:1000 HORIZ (A1)
1:500 VERT (A1)

No.	BY	DATE	DESCRIPTION	APPD
A	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP

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DESIGNED	AK	CHECKED	
DRAWN	AJC	CHECKED	
APPROVED		DATE	

SCALES:
0 10 20 25m
1:1000 (A3) 1:500 (A1) VERT
0 10 20 30 40 50m
1:2000 (A3) 1:1000 (A1) HORIZ

CLIENT:
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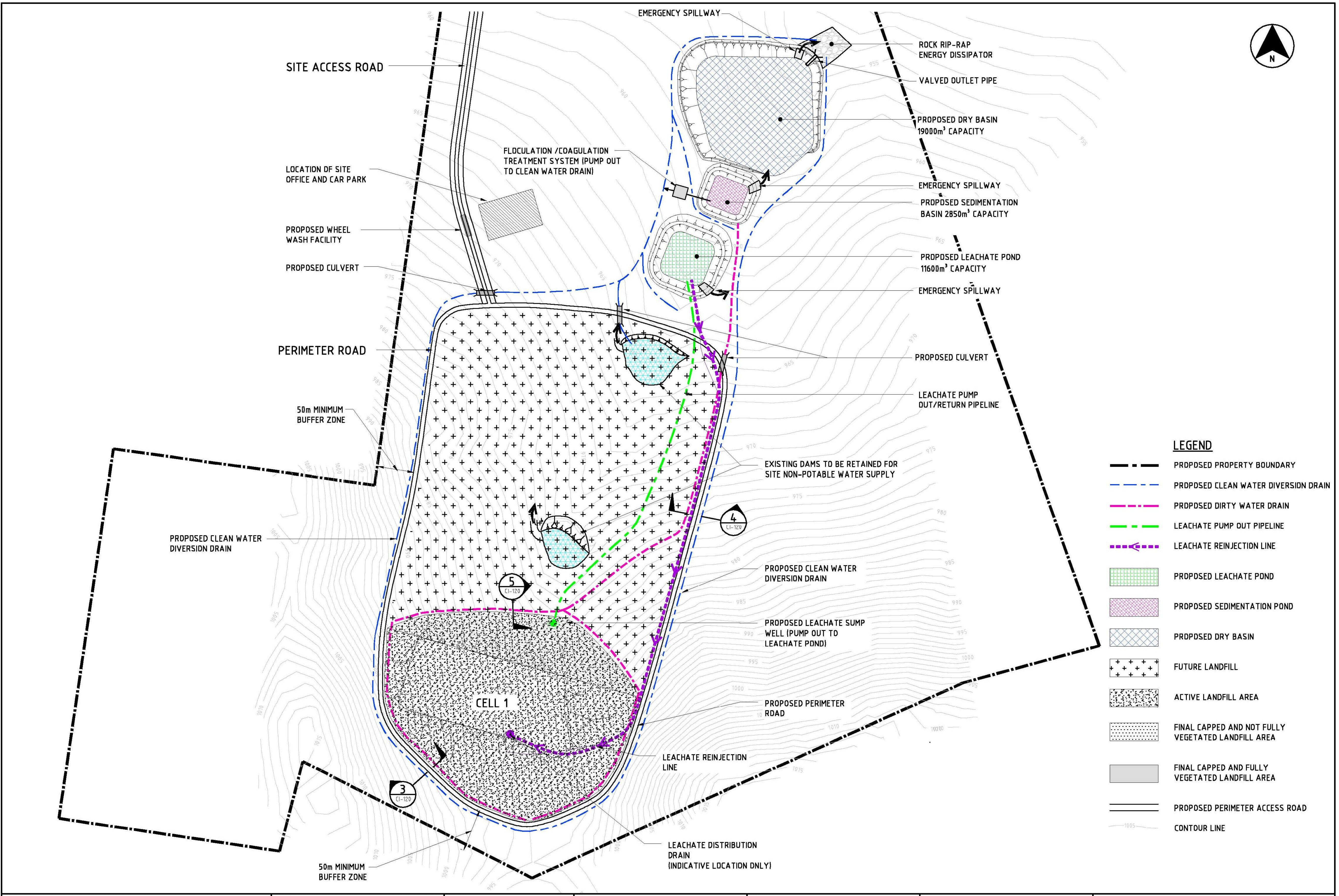
CONTRACTOR:

DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
LANDFILL SECTIONS

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-103
REV: A

Cad ref: C:\Working\Detail\20017605-CI-110.dwg Last modified: 23 Dec 09 - 1356



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No.	BY	DATE	DESCRIPTION	APPD
E	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
D	TT	16.06.08	FINAL ISSUE	AK
C	TT	30.05.08	FINAL FOR REPORT LEACHATE REINJECTION LINE ADEED	AK
B	TT	15.05.08	FINAL FOR REPORT BONDARY REVISED	AK
A	TT	05.05.08	FINAL FOR REPORT	AK

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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 20 40 60 80 100m
1:4000 (A3) 1:2000 (A1)

CLIENT:

CONTRACTOR:

DESIGNER:

AECOM

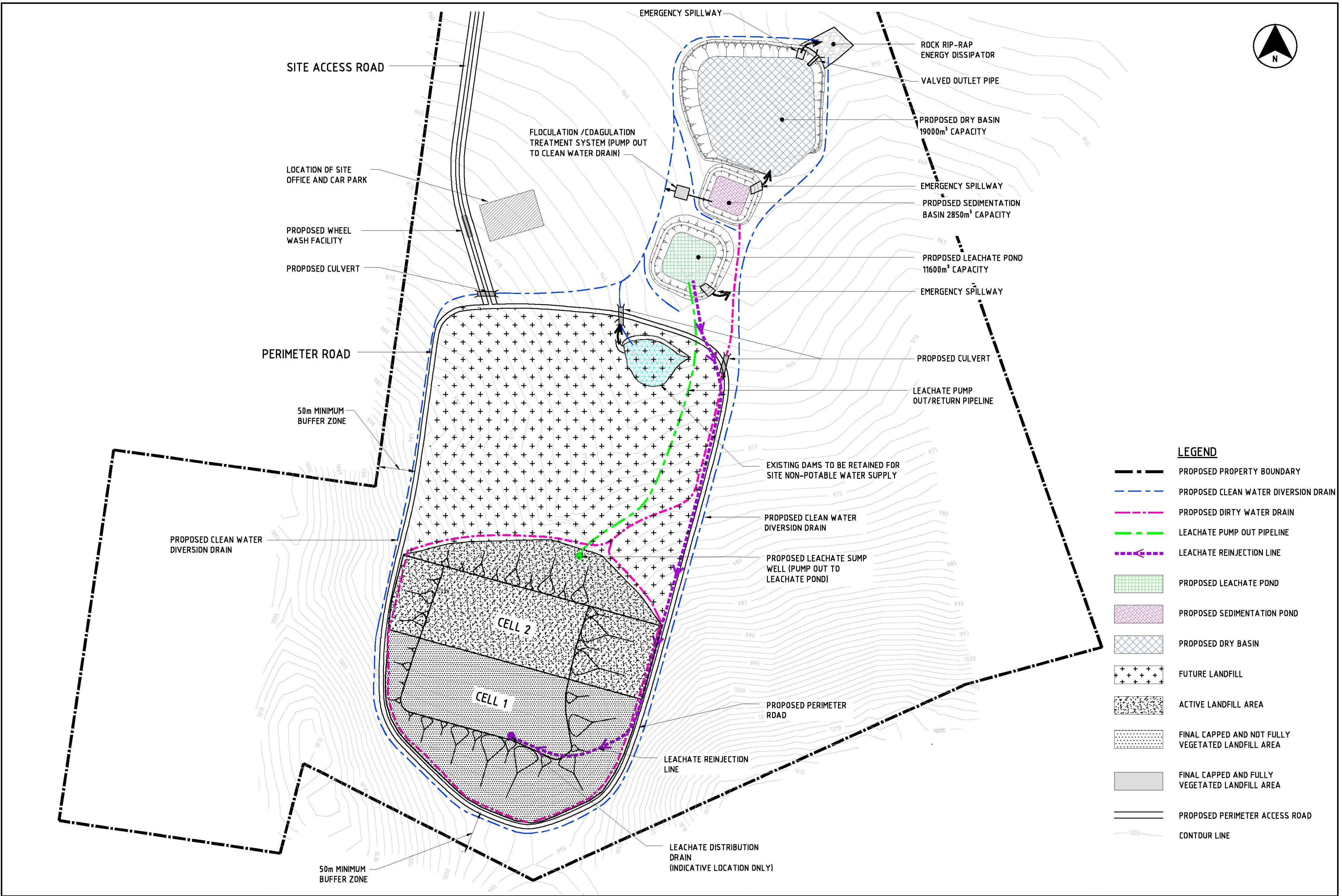
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL

STAGE 1 WATER MANAGEMENT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-110
REV: E

Cad ref: C:\Working\Detail\20017605-CI-111.dwg   Last modified: 23 Dec 09 - 13:56



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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 20 40 60 80 100m
1:4000 (A3) 1:2000 (A1)

CLIENT:
ARMIDALE DUMARESQ COUNCIL
Building the Future

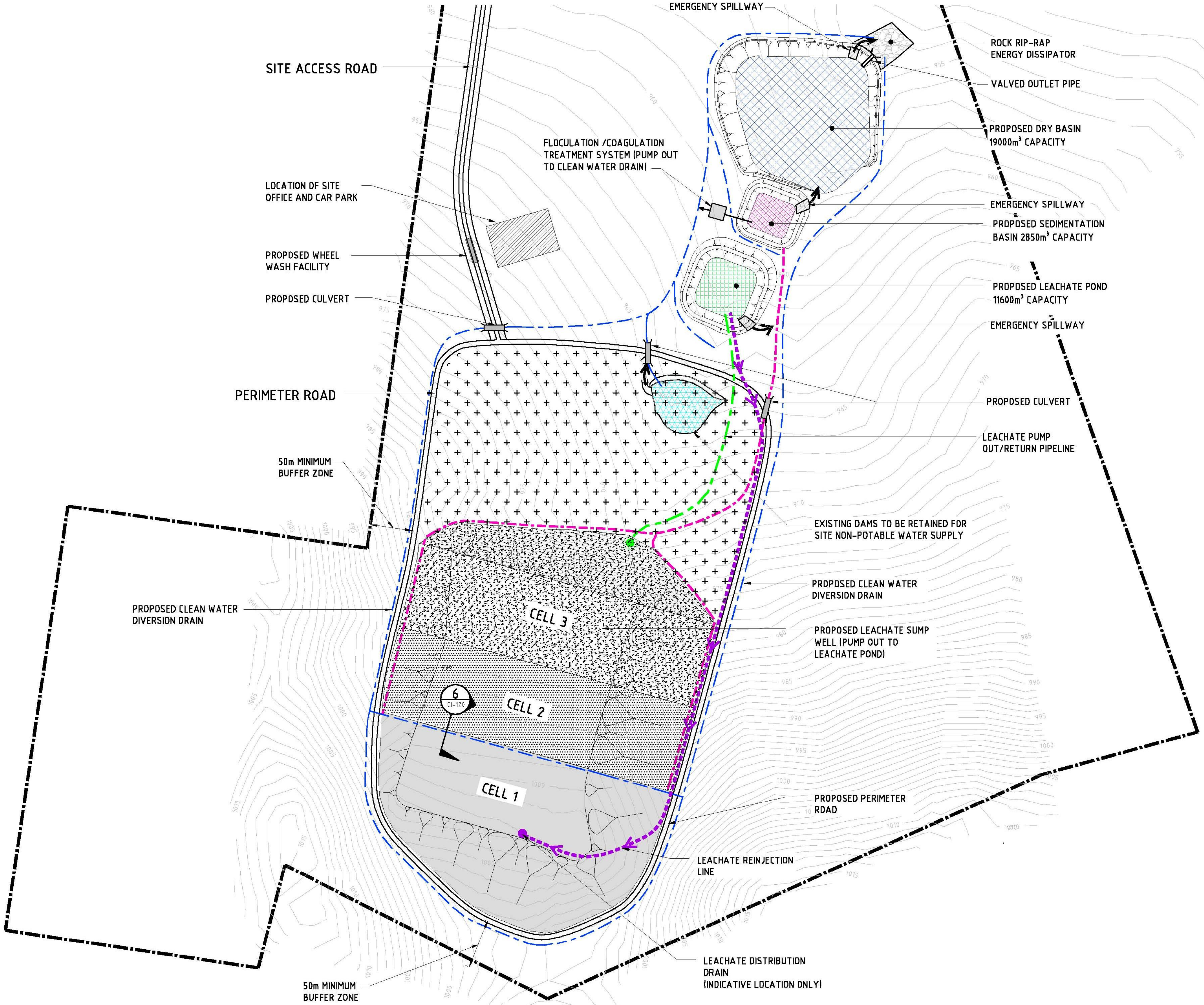
CONTRACTOR:

DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
STAGE 2 WATER MANAGEMENT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-111
REV: E

Cad ref: C:\Working\Detail\20017605-CI-112.dwg Last modified: 23 Dec 09 - 13:56



LEGEND

━ · ━	PROPOSED PROPERTY BOUNDARY
– – –	PROPOSED CLEAN WATER DIVERSION DRAIN
– · –	PROPOSED DIRTY WATER DRAIN
– · –	LEACHATE PUMP OUT PIPELINE
◄	LEACHATE REINJECTION LINE
🟩	PROPOSED LEACHATE POND
🟪	PROPOSED SEDIMENTATION POND
▨	PROPOSED DRY BASIN
+ + +	FUTURE LANDFILL
▒	ACTIVE LANDFILL AREA
░	FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
▩	FINAL CAPPED AND FULLY VEGETATED LANDFILL AREA
═	PROPOSED PERIMETER ACCESS ROAD
---1005---	CONTOUR LINE

This drawing is confidential and shall only be used for the purposes of this project.

No.	BY	DATE	DESCRIPTION	APPD
E	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
D	TT	16.06.08	FINAL ISSUE	AK
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A	TT	05.05.08	FINAL FOR REPORT	AK

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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 20 40 60 80 100m
1:4000 (A3) 1:2000 (A1)

CLIENT:
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CONTRACTOR:

DESIGNER:
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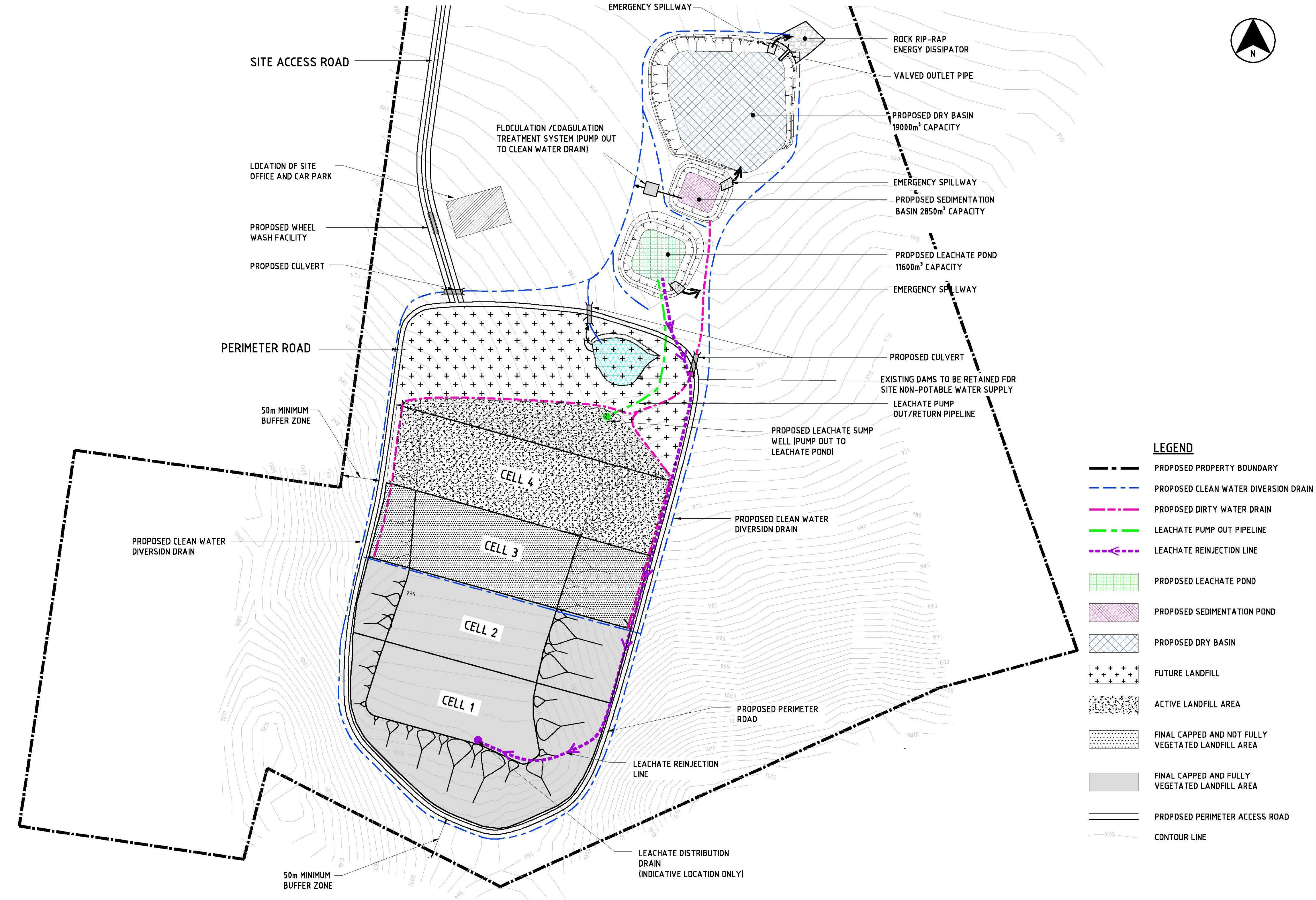
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
STAGE 3 WATER MANAGEMENT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-112
REV: E

Cad ref: C:\Working\Detail\20017605-CI-113.dwg Last modified: 23 Dec 09 - 13:56



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C	TT	30.05.08	FINAL FOR REPORT LEACHATE REINJECTION LINE ADEED	AK
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A	TT	05.05.08	FINAL FOR REPORT	AK

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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 20 40 60 80 100m
1:4000 (A3) 1:2000 (A1)

CLIENT:

CONTRACTOR:

DESIGNER:

RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
STAGE 4 WATER MANAGEMENT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-113
REV: E

Cad ref: C:\Working\Detail\20017605-CI-114.dwg   Last modified: 23 Dec 09 - 13:56

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No.	BY	DATE	DESCRIPTION	APPD
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C	TT	30.05.08	FINAL FOR REPORT LEACHATE REINJECTION LINE ADEED	AK
B	TT	15.05.08	FINAL FOR REPORT BONDARY REVISED	AK
A	TT	05.05.08	FINAL FOR REPORT	AK

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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

SCALES:
0 20 40 60 80 100m
1:4000 (A3) 1:2000 (A1)

CLIENT:
ARMIDALE DUMARESQ COUNCIL
Building the Future

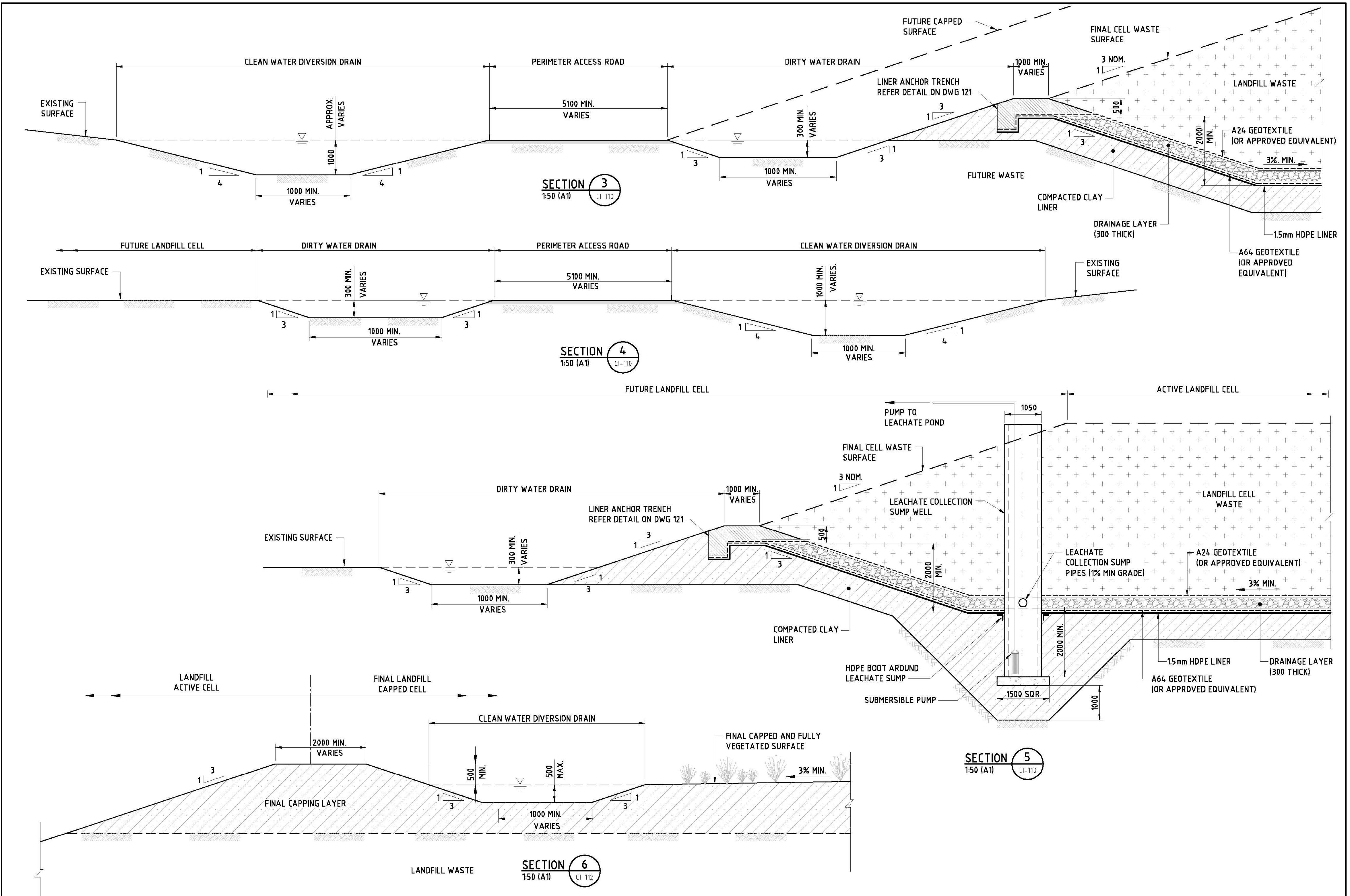
CONTRACTOR:

DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
STAGE 5 WATER MANAGEMENT PLAN

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-114
REV: E

Cad ref: C:\Working\Detail\20017605-CI-120.dwg   Last modified: 23 Dec 09 - 13:51



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No.	BY	DATE	DESCRIPTION	APPD
C	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
B	TT	16.06.08	FINAL ISSUE	AK
A	TT	05.05.08	FINAL FOR REPORT	AK

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CLIENT:

CONTRACTOR:

DESIGNER:
AECOM

RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
TYPICAL DRAIN DETAILS AND SECTIONS

STATUS: DETAILED CONCEPT
DRAWING NO: 20017605-CI-120
REV: C

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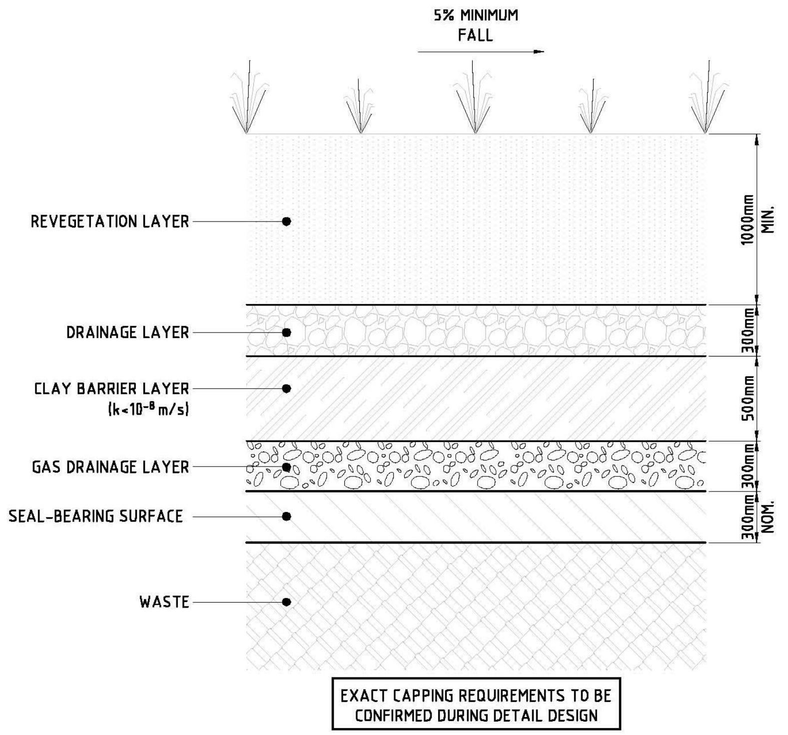

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TYPICAL FINAL CAPPING DETAIL

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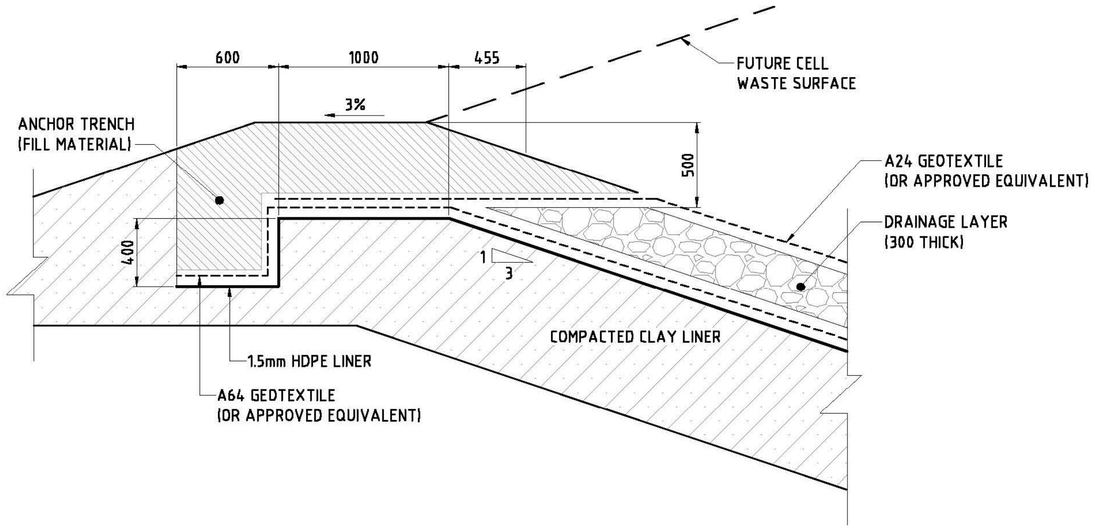

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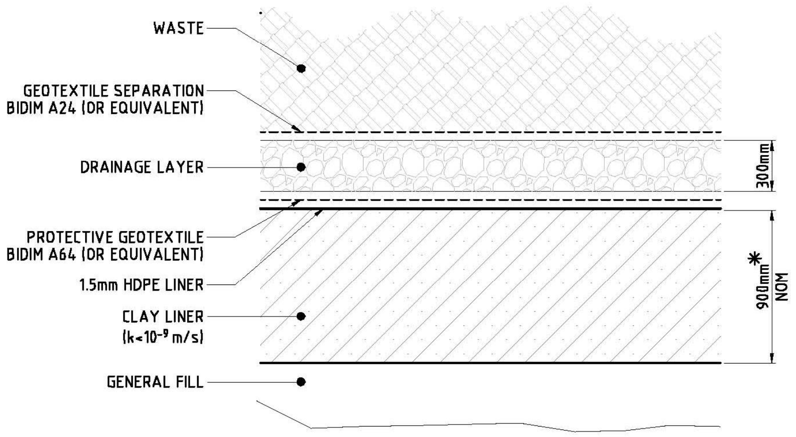

TYPICAL BASE LINER DETAIL

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*EXACT THICKNESS DEPENDENT ON
VOLUME OF CLAY WON ONSITE

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ARMIDALE DUMARESQ COUNCIL
Building the Future

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ARMIDALE LANDFILL

TYPICAL DETAILS

STATUS: DETAILED CONCEPT

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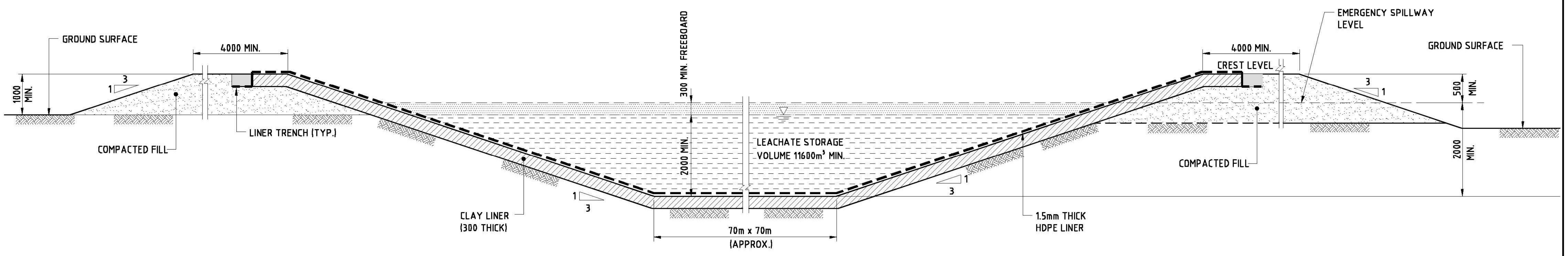

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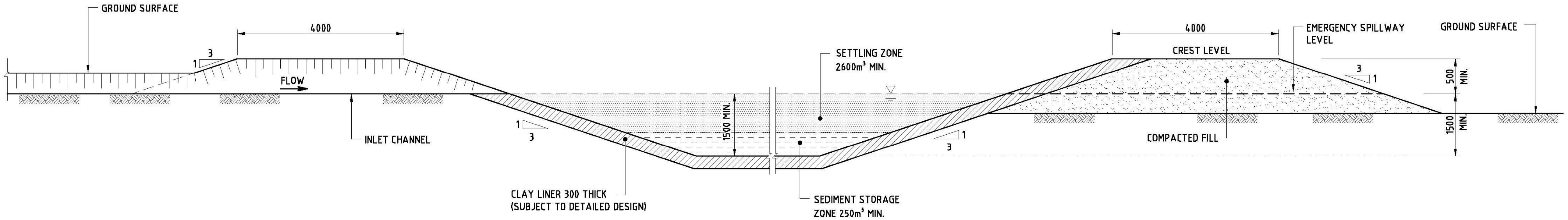

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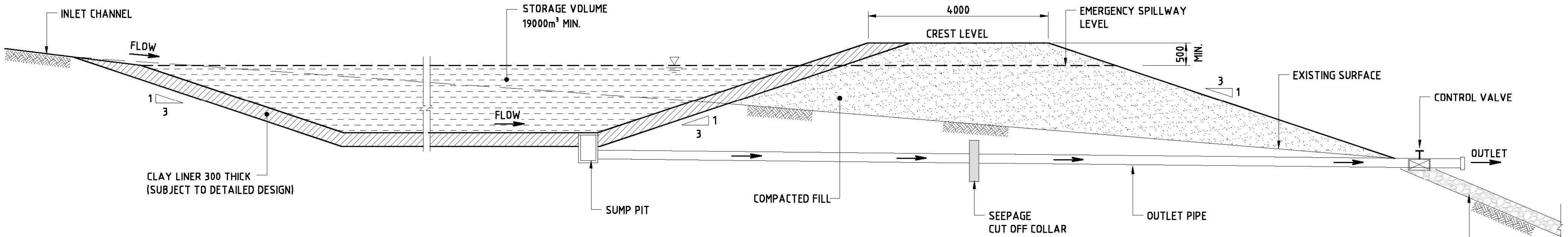

TYPICAL DRY BASIN SECTION

SCALE 1:50 (A1)

ROCK RIP-RAP
ENERGY DISSIPATOR

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ARMIDALE LANDFILL

LEACHATE POND, SEDIMENTATION BASIN AND DRY BASIN SECTIONS

STATUS: DETAILED CONCEPT
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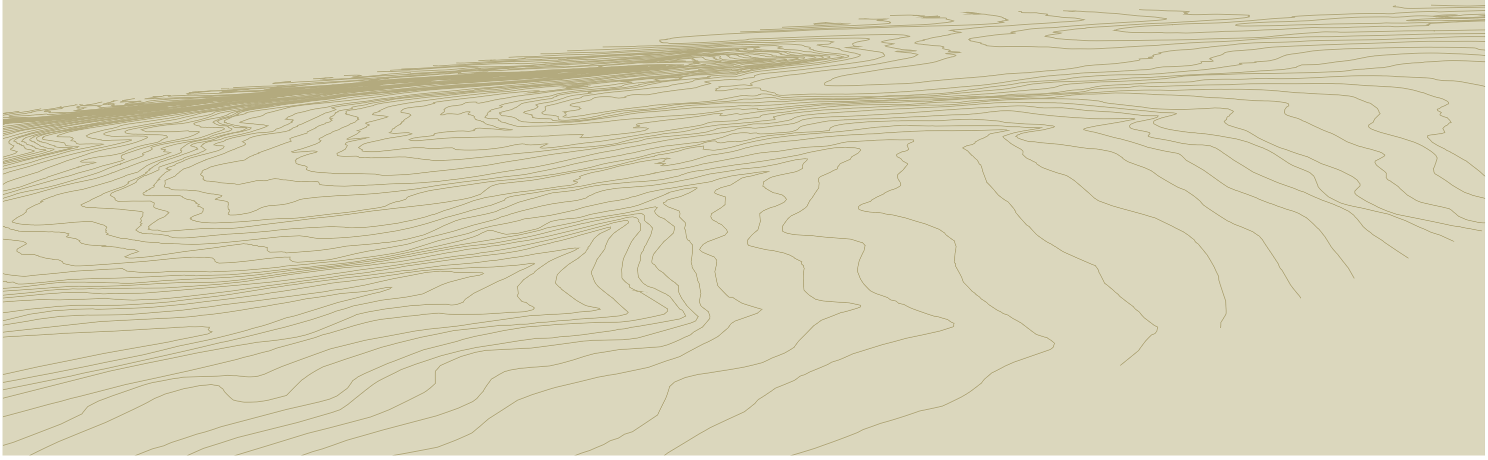
Appendix H

EA Systems, 2009: Biodiversity Offset Management Plan

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



~ Commercial-in-Confidence ~

Biodiversity Offset Management Plan

Proposed New Armidale Landfill Facility

Report Number 22678.38513

Prepared for

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Signatures		E A Broese van Groenou Lisa A Doucette		S. C. Lott.

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Issue 3: Final Report	AECOM EnviroAg Australia	1 pdf 1 pdf

This document provides information to address the intent of Project Number 22678 as agreed to by AECOM.

Executive Summary

The proposed development of the new Armidale Dumaresq landfill will result in the loss of 12.7 ha of Stringybark Woodland, 0.6 ha of Box Gum Woodland in the TSR, 6.5 ha of grassland, two small farm dams and 0.5 ha of sedgeland draining into the Gara River. This loss of habitat will have a significant impact on local populations of two threatened woodland birds (Diamond Firetail Finch *Stagonopleura guttata* and Speckled Warbler *Pyrrholaemus sagittata*) and two provisionally listed birds (Scarlet Robin *Petroica boodang* and Varied Sittella *Daphoenositta chrysolptera*) that have been observed on the proposed landfill footprint area. Habitat loss to these species will be offset by setting aside adjacent areas of similar areas of vegetation that are likely to respond to conservation measures to permanently improve biodiversity values of the offset area.

Areas of vegetation offset or compensatory habitat are proposed to be developed at a 3:1 ratio (i.e. three times more revegetated area than the area quarantined for landfilling purposes). This will result in the protection and regeneration of approximately 61 ha of land within the overall development site. Offsets would be established across the site within areas not proposed for the actual landfilling operations.

This report provides details of the type, location and size of the vegetation offsets and details of the methodology to be used for establishment, monitoring and management of the offset area. Offset management will include fencing and removal of livestock, revegetation and rehabilitation, weed and feral animal control, and relocation of dead wood and dead trees.

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1. Background

E.A. Systems was engaged by AECOM on behalf of the Armidale Dumaresq Council to conduct a flora and fauna and habitat assessment over an area of 314 ha for the proposed development of a new regional landfill facility to be located 12 km east of Armidale on the Waterfall Way. This facility is expected to have an operational life of 50 years. The proposed landfill site will be developed on portions of two rural properties, *Sherraloy* and *Edington,* and a small strip of the adjacent *Gara Travelling Stock Reserve* for site access. The development application for this proposal will be assessed under *Part 3A – Major Projects of the Environmental Planning and Assessment Act* 1979 (EP&A Act).

The significance of impacts of the proposed new landfill on threatened species, endangered populations or endangered ecological communities listed under the NSW *Threatened Species Conservation Act* 1995 (TSC Act) were assessed in accordance with guidelines set out in the *TSC Amendment Act 2002.* The assessment also considered the impact of the proposed development on matters of national environmental significance listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and potential Koala habitat under the *State Environmental Planning Policy 44 - Koala Habitat Protection.*

The proposed development will result in the loss of 12.7 ha of Stringybark Woodland, 0.6 ha of Box Gum Woodland in the TSR, 6.5 ha of grassland, two small farm dams and 0.5 ha of sedgeland draining into the Gara River. Such disturbances reduce the habitat quality of the affected land and may threaten viable populations of threatened species found on the subject site.

It was concluded that the loss of habitat due to the proposed development will have a significant impact on local populations of two threatened woodland birds (Diamond Firetail Finch *Stagonopleura guttata* and Speckled Warbler *Pyrrholaemus sagittata*) and two provisionally listed birds (Scarlet Robin *Petroica boodang* and Varied Sittella *Daphoenositta chrysoptera*) that have been observed on the proposed landfill footprint area. These species were also recorded in the Box-Gum Woodland in the Gara travelling stock route (TSR). Habitat loss to these species on the development site will be offset by setting aside adjacent areas of similar vegetation type that are likely to respond to conservation measures that will permanently improve biodiversity values of the offset area.

Guidelines on how to offset negative impacts upon threatened species and communities of the proposed new Regional Landfill facility have been provided by Department of Environment and Conservation (DEC; now Department of Environment, Climate Change and Water (DECCW)) after a site inspection to assess habitat quality and an assessment of information provided by E.A. Systems' ecologists (Appendix A). These guidelines advise actions and management requirements to maximise the environmental outcomes of offsets recommended for areas surrounding the proposed landfill.

2. Size of Offsets Required

Areas of vegetation offset or compensatory habitat are proposed to be developed at a 3:1 ratio of offset to impact area (i.e. three times more revegetated area than the area quarantined for landfilling purposes). Offset areas will protect and allow regeneration of approximately 61 ha of land within the overall development site. Offsets would be established across the site within areas of the site that are not proposed for the actual landfilling operations.

The Biometric Tool used in the Property Vegetation Planning (PVP) process typically applies offset ratios to impact area of 20:1 for many threatened species in NSW (NSW Department of Natural Resources 2005). However, in this instance DECCW has suggested that there is potential for intensive management of offsets that might greatly improve the biodiversity contribution to the area (Appendix A). Thus, if suitable management effort is incorporated in the proposal, an offset ratio of 3:1 or greater may be appropriate for the landfill (DEC 2006); Appendix A).

The landfill operational area will occupy 20.3 ha. This includes 12.7 ha of regrowth Stringybark Woodland containing Box Gum Woodland elements (i.e. several individual Yellow Box and Blakely’s Red Gum trees), 0.6 ha of Box Gum Woodland within the TSR, 6.5 ha of cleared grassland which will be progressively cleared over the lifespan of the facility, and 0.5 ha of sedgeland. A 3:1 offset to impact ratio will result in an area of 40 ha of Stringybark Woodland, containing individual Yellow Box and Blakely’s Red Gum trees, which will be set aside and managed for conservation to compensate for woodland lost to development. The Stringybark Woodland offset areas will be adjacent to the landfill operational area and are part of an existing remnant of Stringybark Woodland that contains Yellow Box and Red Gum trees. An offset of 21 ha of cleared grasslands within the subject site will be set aside for conservation.

3. Location of Proposed Offsets

The proposed compensatory offset area would surround the landfill site and connect to the Gara TSR (Figure 1 and Figure 2).

DECCW guidelines indicate that they would prefer woodland areas to the south and east of the landfill to be core portions of the offset design and suggest that the biodiversity value of the offsets would be enhanced if these areas connect to other areas of woodland.

Rehabilitation of areas to the west of the landfill pit would provide a linkage to woodland remnants within 600 m of the development. Fencing of the area, which contains some existing Stringybark trees, will allow for a degree of natural regeneration. However, planting of additional trees in the southern portion of this area will likely be required to achieve adequate regeneration of the offset area.

Due to the poor condition of existing vegetation at the site and the limited connectivity to surrounding vegetation, the existing remnant woodland currently has low connectivity value. By using mitigation measures to improve the condition of vegetation, and planting buffers to increase connectivity, the site could be improved to be one of high connectivity value (Department of Environment and Climate Change NSW 2008). The development of a vegetation buffer along the access road will create a corridor connecting the offset area to the Gara TSR and the Gara Remnant Subregional Corridor (Figure 2). The access road buffer area shall be a minimum of 100 m wide to provide a suitable dispersal area for fauna (Department of Environment and Climate Change NSW 2008).

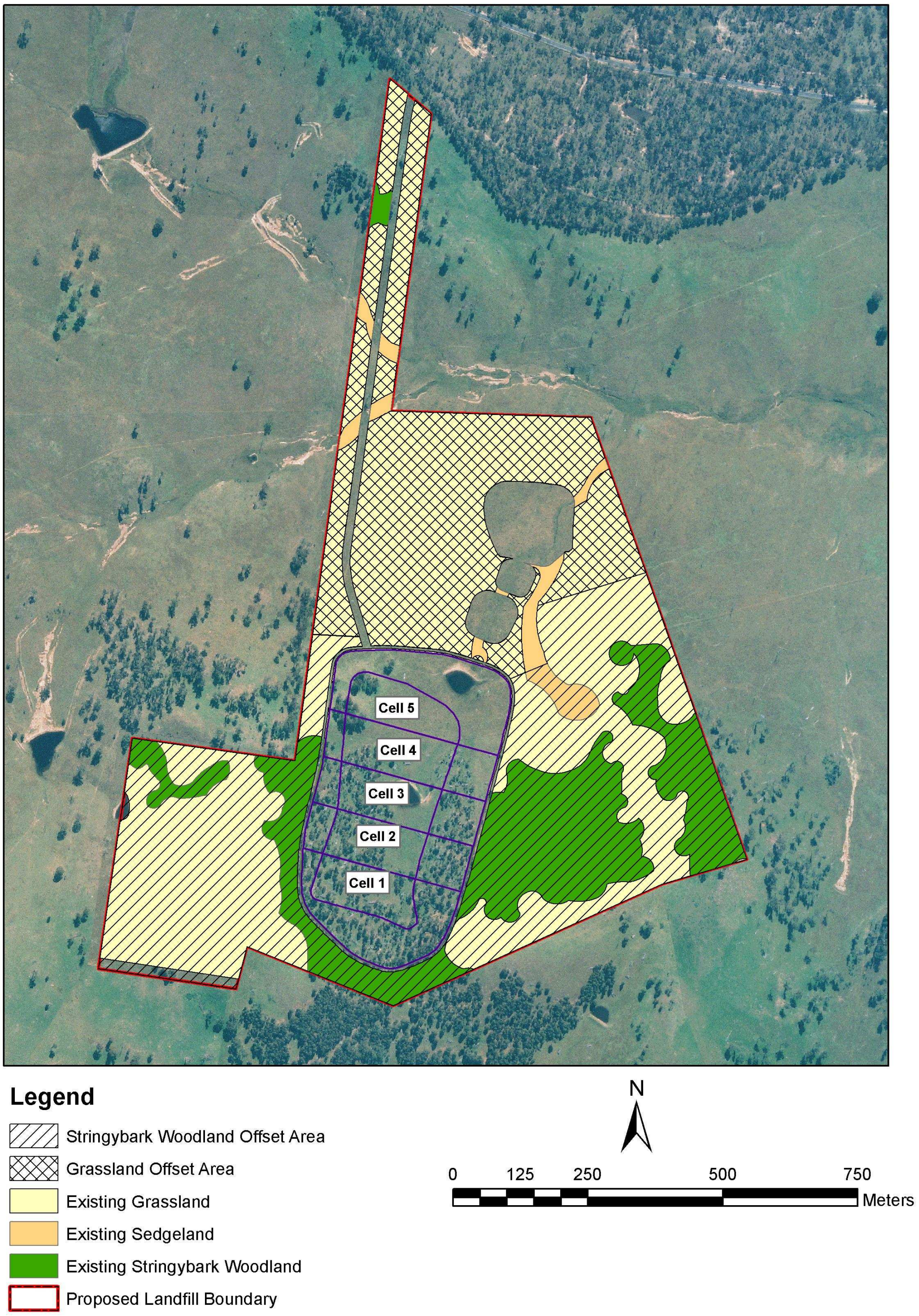

Figure 1. Location of the proposed Stringybark Woodland offset area, the grassland offset area and the area of the landfill pit and associated infrastructure (transparent).

Note: The existing Stringybark Woodland contains some elements of Box Gum Woodland (individual Yellow Box and Blakely's Red Gum trees).

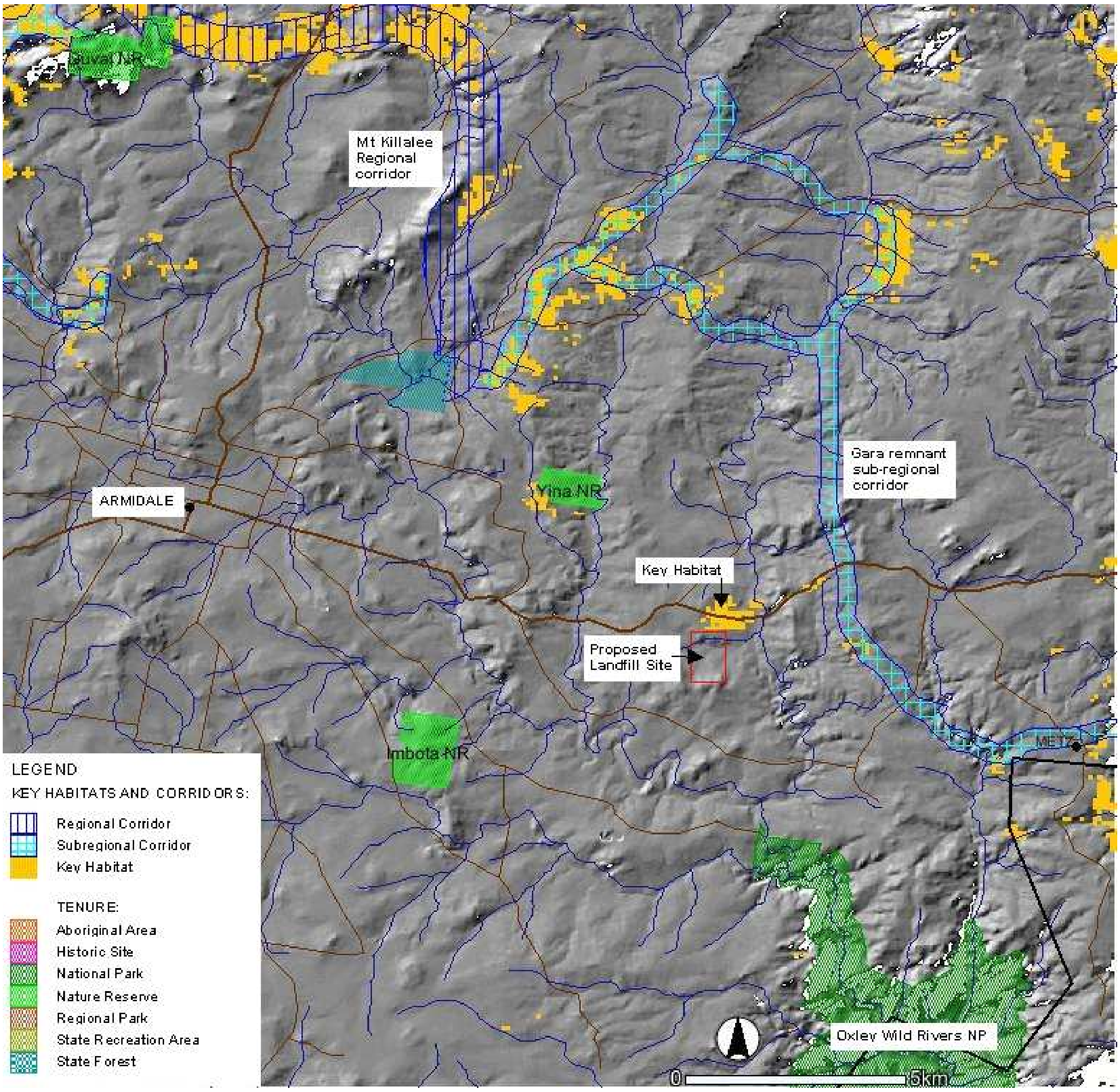

Figure 2. NPWS key habitats and corridors east of Armidale, NSW

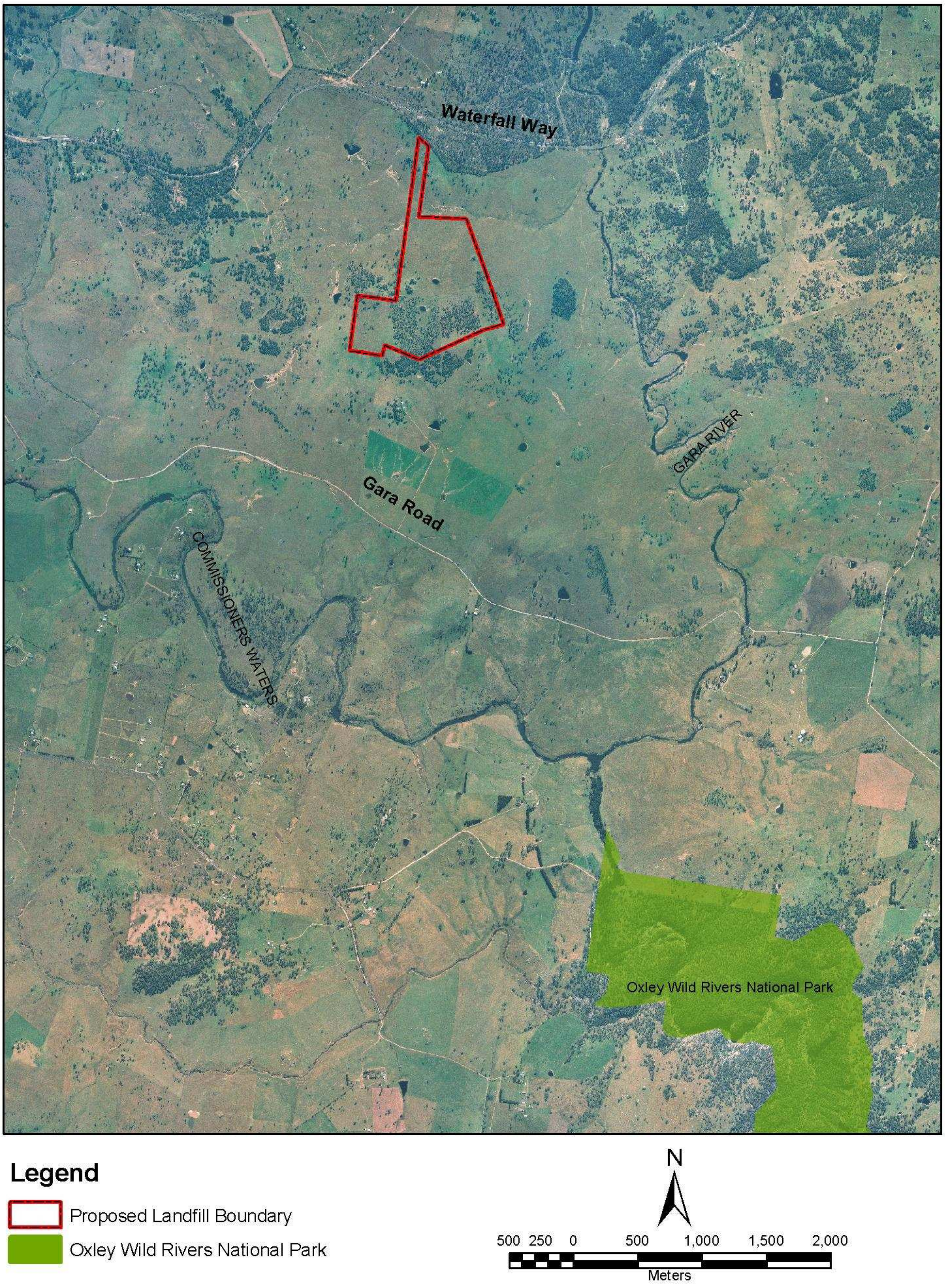

Figure 3. Aerial photo showing local context of study area

4. Offset Rehabilitation and Management

There are several approaches to restoration of degraded patches of temperate woodland remnants. All involve some form of site amelioration (mitigation measures) and removal of the cause of degradation (e.g. livestock) (Lamb 1994). Depending on the nature of the remnant, remediation may also include a reintroduction of biota (e.g. planting, seeding, fauna introductions) (Lamb 1994). This section details the recommended approach to rehabilitation and management of the proposed landfill offset area.

4.1 Fencing and Removal of Livestock

Livestock shall be removed from the offset and fencing erected as soon as possible. This action alone should substantially improve the condition of the vegetation and quality of the habitat for fauna (Yates & Hobbs 1997). Plant species' richness in temperate eucalypt woodlands is radically affected by livestock grazing (Prober & Thiele 1995). The presence of large numbers of stock on a property (as at the time of the fauna survey in 2005) also causes an unnatural increase in soil nutrients, making it unsuitable for some species of native flora and easing the introduction of exotic weeds (Yates & Hobbs 1997). In general, under heavy grazing pressure, native species become less abundant and are replaced by exotic species. Grazing by hoofed livestock also reduces soil viability through compaction and reduced soil water availability, which in turn leads to tree dieback (Yates & Hobbs 1997). With the removal of stock, these processes will be reversed.

4.2 Rehabilitation and Revegetation

All revegetation works will be undertaken by appropriate personnel and supervised by a qualified ecologist. Revegetation works will include a 2 year maintenance period to ensure effective ground cover has been established. Weed control should continue for at least 5 years post-usage of the site as a landfill.

Pre-clearing collection of locally sourced seeds for direct seeding and/or propagation of tube stock should be undertaken in spring/summer prior to commencement of works. Seeds and saplings should be taken from the landfill pit area and either immediately replanted in the proposed offset area or, in the case of seeds, stored for future replanting of spent cells in the landfill pit.

4.2.1 Rehabilitation of Offset Areas

Fencing will be erected to exclude all stock from the offset area. The native vegetation within the grassland offset area (Figure 1) may regenerate naturally after exclusion of livestock. Native plants that grow from natural regeneration will be well-adapted to the site, have high species diversity, and will represent the original range of plant species in the area.

Most of the area within the Stringybark Woodland offset area should regenerate naturally from the existing seedbank and nearby patches of trees (Vesk *et al.* 2009). However, in some areas recruitment can be slow and may require assistance (Yates & Hobbs 1997; Clarke 2002). If understorey regeneration is not satisfactory in areas left for natural regeneration after one year (see Section 5), selected replanting of shrubs and saplings will be necessary in treeless gaps throughout the Stringybark Woodland. The natural recruitment of shrubs has been shown to episodic and disturbance driven (Clarke 2002), and these species may require planting from tube stock. Planting and seeding is best undertaken following autumn rains in cool, wet conditions to ensure maximum success (Minerals Council of Australia 1998; Vesk & Dorrough 2006).

Ground Preparation:

The southeast corner of the offset area, where few Stringybark trees remain, shall be reseeded and/or replanted. The ground will be prepared using deep ripping to a depth of at least 300 mm to increase water infiltration and to allow for easier root penetration. Deep ripping may also assist in reversing soil structural changes caused by livestock (Yates & Hobbs 1997).

Planting:

Seeds collected from the designated landfill pit area will be used for seeding. Sapling Stringybark trees, if available, should be translocated from the landfill pit area prior to clearing and from the dense Stringybark regrowth area within the offset. An effort should be made to maximise that amount of water available to plants during establishment through reducing competition from weeds. Tree guards may be required to protect the young plants from browsing. Planting in rows and planting of monotypic tube stock should be avoided. Fine-scale patchiness can be developed by spacing trees and shrubs at irregular distances and by not planting in straight rows. In the long-term, management of blocks of vegetation by thinning or strategic burning can be used to enhance patchiness (Bennett *et al.* 2000). Thinning of smaller, immature trees in areas of dense regrowth should be conducted in accordance with DECCW guidelines (Appendix A).

4.2.2 Rehabilitation of Landfill Pit

Areas that are not immediately required for operational purposes should not be cleared until necessary. This means that vegetation on cells 4 and 5 may not be cleared until at least 30 to 40 years respectively, after operation of the landfill has commenced.

Pre-clearing collection of locally sourced seeds for direct seeding and/or propagation of tube stock should be undertaken in spring/summer prior to commencement of works for the landfill pit. Before collecting seed, consultation must be made with the relevant authorities to establish what permits and licences are required. Seed should only be collected when it is mature. Woody seed cases (e.g. Eucalypts) and pods (e.g. Acacia) change colour from green to brown at maturity and become either brittle or woody (Minerals Council of Australia 1998). Differential ripening within one species or even a single plant may necessitate several visits for seed collection. Seeds should be stored appropriately for future replanting of spent cells in the landfill pit.

Topsoil Management and Preparation:

Topsoil is almost always an essential factor in successful rehabilitation programs. The original soil contains the appropriate seeds, nutrients and microorganisms that are necessary for plant growth and is the best choice to naturally inoculate the site (Dragovich & Patterson 1995; Fiedler & Groom 2006). The top 100-300 mm of soil removed from the landfill pit needs to be retained and stored for later rehabilitation of the pit (Minerals Council of Australia 1998). It may be feasible to double-strip the topsoil and remove the top 50 mm of soil separately. Seed stores are concentrated in the surface layer and separating a thin layer ensures the majority of seeds remain near the surface from where they can successfully germinate and establish. Soil should be stripped at an appropriate moisture content to avoid compaction and loss of structure (Minerals Council of Australia 1998).

Top soil collected from the landfill pit area prior to excavation shall be stored nearby for up to 3 years (Fiedler & Groom 2006). Soil should be stored in low mounds no more than 1-2 m high

(Minerals Council of Australia 1998). The stockpile should be revegetated to protect the soil from erosion, discourage weeds, and maintain active populations of beneficial soil microbes.

To re-establish sustainable native vegetation on the spent landfill cells the rehabilitation will commence with landform design and the reconstruction of a stable land surface prior to replacing the topsoil (Minerals Council of Australia 1998).

The stripped topsoil should be tested prior to reuse as topsoil acidity may increase over time (Dragovich & Patterson 1995). The use of gypsum or lime may be required to amend the soil prior to use (Minerals Council of Australia 1998). Although native species are adapted to the low nutrient levels common in Australian soils, improved growth and establishment has been achieved following fertiliser application (Minerals Council of Australia 1998), and the addition of fertilizers and nutrients may be required. Application rates of inorganic fertilisers should be assessed according to the results of soil analysis. Seedbed assessment and manipulation has a strong effect on the success of seedling emergence (Clarke & Davison 2001). The seedbed should not be “over-prepared” as a rough “cloddy” surface reduces runoff and provides better protection for seeds and seedlings (Minerals Council of Australia 1998).

Planting:

Fencing will be erected around the spent landfill cells prior to planting to protect young seedlings from animals and damage from machinery. Revegetation shall be undertaken through, direct seeding, planting of tube stock and natural regeneration from the topsoil seedbank.

Direct seeding has the advantage that the distribution of plants is random. Relatively low numbers of seeds should be applied (0.5 kg/ ha) to allow for a greater diversity of plants to establish through natural regeneration. Seeds used in reseeding should ideally be those collected from the native vegetation prior to construction of the landfill pit. Alternatively, seed can be purchased from a reliable nursery. Seeds of some species may require pre-sowing heat treatment (Minerals Council of Australia 1998). To reduce ant predation, seeds will be treated with ‘Coopex’ prior to application (Clarke & Davison 2001; Campbell & Clarke 2006; Lomov *et al.* 2009). Seed inoculation with effective root-nodule bacteria (rhizobia) has also been shown to enhance revegetation success (Thrall *et al.* 2005) and should be implemented if seeds have been stored apart from topsoil for a long period (Minerals Council of Australia 1998). Seeding should be conducted after periods of moderate to heavy rainfall and during periods of consistent rainfall to ensure the maximum success (Vesk & Dorrough 2006).

Direct seeding will be used to establish shallow-rooted native grasses, herbs and shrubs. However, deep-rooted overstorey species cannot be planted directly on the landfill footprint, as their roots may damage the final capping layer over the spent cells. The seed mixture should comprise the most common grasses currently present on the side, potentially including Slender Rat’s Tail Grass (*Sporobolus creber*), Red-leg Grass (*Bothriochloa macra*), Rough Speargrass (*Austrostipa scabra*), Couch (*Cynodon dactylon*), Snow Grass (*Poa sieberiana*), Small Lovegrass (*Eragrostis leptostachya*), Purple Wiregrass (*Aristida ramosa*) and Slender Wallaby Grass (*Austrodanthonia racemosa*). Shrubs are currently not common on-site. Provided the topsoil used to rehabilitate the spent landfill cells is from the existing site, the seedbank should allow shrubs to establish naturally. Seeding with Australian Blackthorn (*Bursaria spinosa*) may assist the shrub layer to establish faster. The shrub layer should be closely monitored to ensure that flora species of value to the threatened fauna species identified on the site are established (Bennett *et al.* 2000). Tree guards may be required to protect shrubs from browsing (Kasel 2008).

Planting in rows and planting of monotypic tube stock should be avoided (Munro *et al.* 2009). Direct seeding sourced from adjacent patches and regeneration of native plants will result in the most natural outcome. Fine-scale patchiness can be developed by spacing trees and shrubs at irregular distances and by not planting in straight rows. In the long-term, management of blocks of vegetation by thinning or the use of fire can be used to enhance patchiness (Bennett *et al.* 2000).

Recent studies have shown that the use of mulch after replanting reduces the diversity of re-established flora (Fiedler & Groom 2006). Given the relatively mesic environment of the Armidale area, mulch should not be required and its use should be avoided. Instead, an effort should be made to maximise that amount of water available to plants and seeds through reducing competition from weeds. Care must be taken to not disturb the topsoil after seeds have started to germinate as this will cause a substantial reduction in plant establishment (Minerals Council of Australia 1998).

For one year after planting the survival rates of plants will be assessed to determine the necessity for replacing dead plants. It is assumed that 10% of the seedlings will require replanting.

Management of the landfill area will be adaptive depending on the responses of native flora and fauna to rehabilitation and management actions. Unforeseen changes in conditions may result in minor adaptations to management actions in order to improve the chances of favourable outcomes from year to year.

4.2.3 Buffers

Vegetated buffers will be planted along the access road and around the landfill pit and infrastructure areas (within the offset areas and outside the landfill perimeter fencing). These areas should be established and planted in the early stages of project construction and removal of existing vegetation from the landfill pit be delayed as long as possible to achieve maximal overlap.

Buffer plantings along the access road will be designed to supplement existing native stands and enhance connectivity between patches of remnant vegetation, including the Gara TSR. Native trees and shrubs will be planted in a configuration to mimic the natural landscape and will occupy the maximum width of the road corridor.

All plantings will consist of locally occurring native species, propagated from locally collected seed or other propagules. Shrubs, herbs and grasses will mostly be allowed to regenerate naturally.

Planted buffer areas should be maintained by a horticulturist for a period of 24 months. During this period any trees that die will be replaced. Additional seeding will be implemented as necessary. Wooded areas shall be monitored to ensure regeneration includes all facets of native vegetation and the establishment of weeds is prevented (see Section 5).

A firebreak shall be constructed around the perimeter of the Stringybark Woodland offset, and around the perimeter of the grassland offset.

4.3 Removal of Mature Trees

The number of mature trees requiring removal within proposed irrigation areas will be limited to the minimum necessary for the safe construction and use of the proposed development. Mature trees to be retained will be marked to ensure machinery operators take due care in their vicinity and minimise any damage that may otherwise occur.

Prior to removal of hollow-bearing trees in woodlands and grasslands, hollows will be checked for nestlings and arboreal mammals, such as possums and insectivorous bats. Diurnal and nocturnal stag watches should be undertaken for each hollow-bearing tree or cluster of trees.

Tree hollows should be re-checked for animals after felling or pushing. All fauna found will be safely relocated to the offset areas with the supervision of a zoologist or wildlife rescuer. Injured or sick animals will be taken directly to a local veterinarian for treatment.

4.4 Weed Control

The control of exotic plant species is one of the most important issues for any eucalypt woodland restoration program (Yates & Hobbs 1997). Without adequate control of weed species, any areas left for natural regeneration may rapidly become overrun by exotics.

Twenty-eight (28) weed species were recorded in the grassland, sedgeland and Stringybark Woodland communities within the landfill development area. The dominant species were Spear Thistle (*Cirsium vulgare*), which dominated some areas of grassland, and Hawthorn (*Crataegus monogyna*), Blackberry (*Rubus fruticosus*) and Sweet Briar (*Rosa rubiginosa*) mostly within the numerous large log piles in the Stringybark Woodland.

Four (4) species of noxious weeds declared under the *Noxious Weeds Act 1993* for the Armidale Dumaresq Local Government Area (LGA) are present on the study area: African lovegrass (*Eragrostis curvula*), Bathurst Burr (*Xanthium spinosum*), Blackberry and Sweet Briar. Although not currently present on site, control and monitoring of invasive exotic grasses, such as Coolatai Grass, Serrated Tussock, and Chilean Needlegrass, which may spread from the Waterfall Way access route to the new landfill site should also be undertaken. Management of weeds shall be undertaken as required by law under the *Noxious Weeds Act* 1993.

Noxious weeds will be treated with spot-spraying of glyphosate and thinning/slashing/pulling implemented where required. All use of herbicide must comply with the directions on the attached labeling and with regard to the provisions of the *Protection of the Environment Operations Act* 1997. The ‘cut-and-paint-stump’ method is recommended for removal woody weeds (Blackberry, Sweet Briar and Hawthorn). This involves completely cutting the trunk or stem of the plant as near as practical to ground level and applying a herbicide to the cut surface within 30 seconds.

Weeds control should continue for up to 5 years after planting/seeding of offset areas and spent landfill cells. Two comprehensive searches for weeds will be implemented each year, one in late spring (November) and another in late summer (February).

It is unlikely that weeds will spread neither from landfill waste placed in the operational pit areas nor from rehabilitated pit areas since green (garden) waste will be processed at the Long Swamp Road Waste Transfer Station. It is understood that Council does not intend to landfill any green waste at the proposed development site on Waterfall Way. The potential introduction and spread of weeds from the landfill is more likely to be associated with soil disturbance and earthworks during the construction and rehabilitation phases of the landfill operation.

It is recommended that the following mitigation measures be undertaken during development works to prevent the spread of weeds:

- Wash down vehicles to remove weeds and weed seeds to prevent spread to new areas. Wash down should occur in a dedicated area where runoff can be contained and weeds treated.
- Ensure that all materials imported onto the site are weed and disease free.
- Do not transport topsoil. Re-spread topsoil as close as possible to the area it was stripped from.
- Monitor and control weeds following ground disturbance and construction works: use only non-residual herbicides and those without surfactants (spreading agents) in the vicinity of drainage lines (surfactants can lead to suffocation of amphibians).

- Residual herbicides may be used in table drains only if they are used in a spot spray manner (residual herbicides persist in the soil and can be washed into watercourses).
- Appropriate control of drainage and run-off that may spread weed seeds or high levels of nutrients.

4.5 Feral Animal Control

Habitat modification may be the most suitable technique for Rabbit control. Removal of surface refuge greatly enhances the effectiveness of control programs and slows recolonisation. This may be achieved through measures such as dismantling existing log piles and removing blackberry thickets. Due to the presence of raptors (e.g. Little Eagle) at the site, baiting with 'Pindone' is not recommended, however the use of 1080 may be suitable. Log piles should be dispersed as individual logs scattered throughout the offset areas (both Stringybark and grassland), to retain fauna habitat (e.g. foraging substrate for threatened birds) while minimising shelter for Rabbits.

The reduction of Rabbits at the site will help to control Fox and potential cat populations in the area. The removal of log piles will also serve to reduce harbour available for these species. Covering waste in a timely manner should reduce exposure of waste to these pest species and minimize enticement.

A specialist in feral animal control should be consulted to determine the best management approach for existing and potential feral animals at the site. If an outbreak is detected, a professional exterminator shall be employed.

4.6 Relocation of Dead Wood and Dead Trees

Hollow-bearing stags in the grassland and hollow-bearing trees from Stringybark Woodland in the landfill area will be relocated to offset areas as logs, or erect as stags if feasible, in line with DECCW recommendations (Appendix A).

Log piles within the landfill pit area of the Stringybark Woodland should be redistributed to the offset areas and dispersed as single logs to emulate natural conditions (Munro *et al.* 2009). Fallen branches and timber should be allowed to accumulate over time in the offset area. Stumps with the potential to stand upright should be positioned to allow for birds and arboreal mammals to use the hollows for nesting and roosting.

4.7 Enhancing the value of the offset for native fauna: structural complexity

Fauna depend on a diversity of vegetation types and structural complexity to provide foraging substrate, shelter and nesting habitat (Bennett *et al.* 2000; Kavanagh *et al.* 2007) and structurally complex revegetation will support a greater diversity of species (Munro *et al.* 2007). To support fauna that may be displaced and negatively impacted by the development, natural layers of structural complexity and patchiness of vegetation must be re-established in the offset area through a mixture of plant species regrowth (Munro *et al.* 2009). Layers of vegetation can be established by selecting plants that grow to different heights, such as trees, tall shrubs, low shrubs and groundcover. Fine-scale patchiness can be developed by spacing trees and shrubs at irregular distances and by not planting in straight rows. In the long-term, management of blocks of vegetation by thinning or the use of fire can be used to enhance patchiness (Bennett *et al.* 2000).

The habitat requirements of animal assemblages and species differ widely. Studies of arboreal marsupials have shown that some members of this group can recolonise revegetated areas if hollows are present or provided as nest boxes (Suckling & Goldstraw 1989). Complex groundcover elements, including fallen logs and debris, are essential for recolonisation by small native terrestrial mammals (Munro *et al.* 2007). The number and diversity of avian species inhabiting revegetated woodland appears to be directly related to the composition of the vegetation layers with the development of the understorey being of particular importance (Munro *et al.* 2007). Studies show that common bird species can recolonise revegetation within 2-3 years provided the understorey is well-developed (Munro *et al.* 2007). Bird species richness tends to increase with revegetation age and declining and uncommon birds may take more than 8 years to recolonise (Taws *et al.* 2001).

Several threatened species of birds are likely to be displaced due to construction of the landfill pit. However, the impacts will be minimised through the staged clearing required for construction of the landfill over its proposed 50 year lifespan. This will allow the maximum possible amount of habitat to remain while the Stringybark offset area becomes progressively more established. A complex structural habitat, with multiple layers of vegetation, should be established in the offset areas prior to extensive clearing for the landfill pit and associated infrastructure. The habitat requirement for each of these species differs:

The Diamond Firetail Finch (*Stagonopleura guttata*) builds bottle-shaped nests in trees and bushes, but largely forages on the ground for grass seeds and insects. This species will require well-established overstorey, shrubs and groundcover to successfully inhabit the offset area.

The Speckled Warbler (*Pyrrholaemus sagittata*) nests and forages on the ground for arthropods and seeds in grassy patches, leaf litter and shrub cover (Ford *et al.* 1986) and are thus very susceptible to predation. The successful assessment of groundcover and a shrub layer is important for the survival of this species. However, more important for the survival of this species are the removal of existing introduced predators on the site (Foxes) and the prevention of an increase of cat numbers on the site as a result of the landfill. Speckled Warblers are known to respond well to replanted eucalypt woodlands (Kavanagh *et al.* 2007).

Varied Sittellas (*Daphoenositta chrysoptera)* forage socially on insects, by clambering among tree branches and probing bark and dead wood. They build an open, fibrous nest in upright dead forks of trees (Higgins & Peter 2002). The successful established and retention of mature trees on the site is paramount to the survival of this species.

Scarlet Robins (*Petroica boodang*) forage on insects, mostly by pouncing to the ground from a low perch. They build an open, fibrous nest, typically in a fork of a mature living tree and sometimes on a dead branch (Debus 2006). Both a well-established groundcover layer and tree canopy are required by this species.

It is expected that the Little Eagle (*Hieraaetus morphnoides*) pair on the site will move to a new nest location when: a) their nestling has fledged and disturbance near the nest/roost tree increases; and b) the number of Rabbits, their primary food source on the site, is reduced. Thus, we predicted that the Little Eagles will not be significantly impacted by the development provided several large mature trees, such as Yellow Boxes are retained on the site (Broese *et al.* 2009). Little Eagles breed in a stick nest in a living woodland tree and the long nesting cycle lasts from late winter to early summer (Debus *et al.* 2007; Debus & Ley 2009).

The successful establishment of a multi-layer complex habitat may also offer the native species some protection from exotic and native pest species. For example, Noisy Miners (*Manorina melanocephala*) are an increasing problem in Australian landscapes and dominate small patches and competitively exclude other small woodland birds (Ford *et al.* 2001). The establishment of shrubs, such as native Acacias, in the offset woodland may reduce the number of Noisy Miners (Hastings & Beattie 2006). In a study by Hastings and Beattie (2006), the greatest abundance and richness of small birds occurred in plantings combining eucalypts with at least 15% Acacias. Hastings and Beattie (2006) recommend that eucalypt plantings be supplemented with both Acacias (preferably bipinnate) and a shrubby understorey to deter Noisy Miners.

5. Offset Monitoring

On-going annual monitoring of revegetation is required to determine the success of regeneration within the offset areas and within the landfill pit as each cell is rehabilitated. Vegetation surveys of established monitoring plots should be undertaken in late spring-summer to maximize the numbers of species recorded and ensure accurate identification. Monitoring plots should be established in the offset area prior to vegetation removal for the landfill pit and infrastructure.

Understorey response to grazing removal should be monitored from the outset. If understorey response is minimal, assisted regeneration (revegetate with local tree and shrubs seeds or seedlings) will be required, especially in treeless areas. A density of >2,000 stems per 5 ha is considered adequate regrowth. Growth and stand structure response shall also be monitored to assess the response of the understorey to thinning.

5.1 Establishment of plots for ongoing vegetation monitoring

Prior to vegetation removal for the landfill pit and infrastructure, vegetation monitoring plots (20 x 50 m) will be established in the designated offset areas. A minimum of three plots shall be established in representative vegetation for the grassland area, three plots established in the Stringybark vegetation in good condition (regrowth), and three in the areas that will likely required revegetation (areas near Stringybark Woodland currently designated as grassland; Figure 1) for a total of nine monitoring plots.

These plots aim to detect changes in response to site rehabilitation and monitoring shall commence with the collection of baseline data. This information will provide the benchmark from which ongoing monitoring will be measured and assessed in terms of the success of the rehabilitation works.

5.2 Monitoring vegetation regeneration (diversity assessment)

Within the 50 x 20 m plot, numbers of individual stems of native trees and shrubs by species will be counted to determine diversity. Dead trees or stumps >1 m high will also be counted and denoted as ‘dead tree’.

Trees less than 10 cm in diameter will be further classified in terms of height. This will assist with the monitoring of seedling growth and regeneration. A density of >2,000 stems per 5 ha is considered adequate regrowth. Less than 2,000 stems per 5 ha area will require assisted rehabilitation by planting or seeding of native species.

The number of vegetation layers (strata) should be noted and described in categories for trees, tall shrubs, low shrubs and groundcover (Thackway *et al.* 2006). Notes will be made of the presence of exotic weed species where appropriate.

The abundance of fallen timber >10 cm diameter will be recorded in terms of the total length of logs present in each transect. Logs will be separated into diameter size classes related to the tree diameter at breast height (DBH).

5.3 Monitoring Groundcover

Vegetation groundcover will be assessed within the 20 x 20m plot as percentage of native grasses, native shrubs, native other (forbes and herbs) and exotic plant cover. For the baseline study, all native and exotic species will be identified to species. The quality of the remnant vegetation community present will also be assessed for the level of ground disturbance (from animals or human activity) and organic litter coverage.

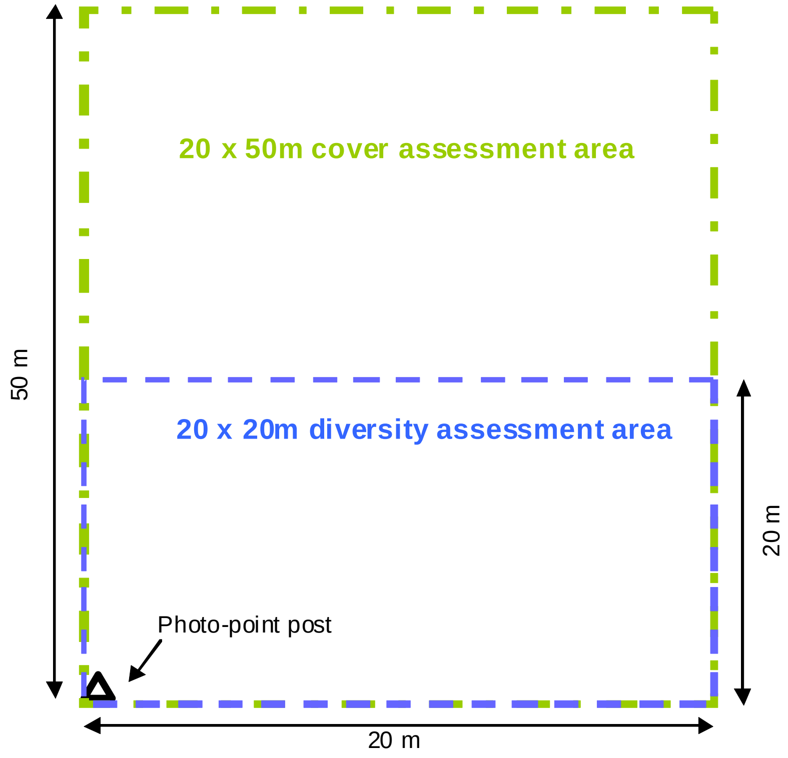

Figure 4. Monitoring plot layout

5.4 Photo Points

A digital photo will be taken at the southwest corner of each plot and the location and aspect recorded using a GPS and compass. The location of the photo point will be marked using a labelled star picket as a permanent marker.

5.5 Reporting

An annual report of the assessment will be produced detailing the following:

- Digital photos with GPS locations and aspect for each monitoring plot;
- Ground cover assessment;
- Tree & shrub diversity;
- Tree height for trees less than 10 cm in diameter (regeneration measure);
- Calculation of total number of species, total stems (20 x50 m), and estimated stems per 5 ha for each plot;
- Fallen timber;
- Ground disturbance;
- Organic leaf litter coverage;
- Presence and estimated density of exotic weed species; and
- A discussion on the density and diversity of natural regeneration occurring in each plot.

6. Statement Addressing the Principals of Biodiversity Offsetting

DECCW (previously the Department of Environment and Conservation DEC) has outlined a number of principles for biodiversity offsetting (Appendix A). We have briefly addressed each of these criteria in terms of the conditions on the proposed landfill site.

1. Offsets are used to address residual impacts following consideration and implementation of options to avoid, minimise and mitigate impacts.

Options to avoid, minimise and mitigate impacts of the proposed landfill on threatened species and ecological communities have been taken into consideration and are discussed in Broese *et al*. (2009). Offsets will be used to create additional habitat for four species of woodland birds that will lose territories for individual pairs as a result of landfill construction.

The area designated for the landfill is currently highly degraded. The condition of the proposed offset areas will be rehabilitated according to DECCW's recommendations (DEC 2006) and the condition will gradually improve to a status more suitable for species conservation.

The construction of the landfill pit will be completed on a cell-by-cell basis. Thus, vegetation in the final cells will not be cleared for 30-40 years after commencement of landfill use. After each cell is full, it will be covered and rehabilitated. This will minimise the size of the area impacted at any given point in time.

2. Offsets should be based on an agreed understanding of the conservation significance of the impact and offset values.

A full assessment of the conservation significance of threatened species and vegetation communities was conducted as part of the flora and fauna assessment (Broese *et al.* 2009). The proposed offset areas are of the same vegetation types as the proposed clearing, a 3:1 ratio of offset to impact area for Stringybark Woodland and native grassland.

An important component of the offset is their potential to maintain or increase the connectivity value of the landscape. The vegetated buffer to be reconstructed along the access track will link habitat between the Stringybark Woodland in the south of the site with Box-Gum Woodland in the north in the Gara TSR (Figure 1).

3. Offsets should maintain or improve identified biodiversity values secured into the future.

Mitigation measures and rehabilitation of the offset area should compensate for the loss of biodiversity within the impact area. DECCW has agreed to a 3:1 offset ratio to provide habitat for the woodland bird species to be impacted by the development. The mitigation measures proposed for the offsets, including exclusion of grazing, redistribution of fallen timber (as single logs), and weed and pest control will improve the conservation value of the site overall. These mitigation measures should improve tree recruitment and understorey condition and diversity in the landfill and offset areas (Yates & Hobbs 1997).

4. Offsets should be based on a "like for like" basis.

Clearing of 12.7 ha of Stringybark Woodland and 0.6 ha of Box Gum Woodland will be replaced by the conservation and improvement of 40 ha of similar Stringybark Woodland regrowth area. As the Stringybark Woodland in the proposed landfill area contains Box Gum Woodland elements, the Stringybark Woodland offset area will be enhancement planted with Yellow Box and Blakely's Red Gum trees, particularly in the vicinity of existing trees of these species in the Stringybark offset area.

Clearing of 6.5 ha of grassland and 0.5 ha of sedgeland will be replaced by the conservation and improvement of 21 ha of cleared grassland.

5. Offset area should be greater than the area impacted.

A 3:1 offset to impact ratio has been proposed for the landfill site (DEC 2006).

The area proposed for the offset of both Stringybark Woodland and grassland is in similar condition to the area to be cleared. The condition of the offset areas will be improved by mitigation.

6. Offsets should generally be in proximity to the area impacted.

The offsets will be adjacent to the Stringybark Woodland and grassland to be impacted, respectively. Applying the offset locally minimizes the risk that any one area receives an unreasonable burden of impacts without receiving the benefits that offsetting can provide. Providing offsets and improving habitat condition adjacent to the impact areas should allow the four threatened bird species at the site to relocate from the impact area to the offset area and the genetic diversity of the populations in the local area will be retained.

7. Offset actions should be located in areas of strategic regional conservation value where Principle 6 does not apply.

Principal 4 (like-for-like) and principal 6 (offset adjacent to impact area) have been satisfied for this proposal.

8. Offsets should be in addition to existing initiatives.

The proposed offset areas are in addition to mitigation measures proposed for the site in the flora and fauna assessment (Broese *et al.* 2009). Initiatives include assisted regeneration of degraded habitat, relocation of logs from log-piles, fencing, and pest and weed control.

9. Offsets should minimise ecological risks from time lags.

Construction of the landfill pit and infrastructure should not commence until offsets have been designated and rehabilitation of suitable areas of the site has commenced. Fencing and rehabilitation of the offset areas should commence as early as possible.

Each cell of the landfill will be rehabilitated as it is completed and unused cells will not be cleared until they are needed.

10. Offsets should be secure, long term and auditable.

Offset areas can be protected in perpetuity through:

- Vesting ownership in Council, Land Trust or BioBank;
- A formal conservation agreement (Voluntary Conservation Agreement (VCA) under the NPW Act bound to title prior to on-selling; or
- A covenant on title placed on the land under section 88b of the Conveyancing Act 1919.

The appropriateness of targets and strategies of the management plan will be reviewed every 5 years.

Mandatory documentation of offset agreements must convey full details about all locations and actions involved in an agreement. A spatial record on a centralised GIS spatial database, managed by DECCW and accessible by DECCW officers is also required (DEC 2006).

7. Summary of Mitigation Measures

After extensive negotiation between the Department of Environment, Climate Change and Water, Armidale Dumaresq Council and E. A. Systems consultants it has been agreed to implement the following beneficial management actions:

- Progressive clearing of trees on the landfill area on a cell by cell basis;
- Fencing of offset areas with livestock-proof but wildlife-friendly fencing (avoiding barbed wire if possible);
- Control of exotic herbivores (Rabbits) in the offset areas. (A Rabbit control plan will include close monitoring of densities of Rabbits and immediate control of new irruptions);
- Control of any cat populations associated with the landfill;
- Control of Foxes in the offset area, especially if part of a broader regional program with neighbouring properties. Localised control of Foxes reliant upon the landfill is required;
- Ongoing control of noxious weeds;
- No burning for hazard reduction in offset areas, and construction of perimeter firebreaks around the offset areas. (If hazard reduction burning is required as a buffer to the landfill, the design must minimize the area burned or preferably use slashing to achieve a narrow buffer);
- Relocation of hollow trees from landfill area to offset areas as single logs (not log piles which create Rabbit harbour), or erect as stags if feasible;
- Relocation of all logs that are >20 cm diameter at any point off the landfill site to the offset area, as single dispersed logs (not log piles);
- Rehabilitation of tree cover in selected areas to begin as soon as possible after stock removal;
- Monitoring of understorey response to grazing removal to be initiated prior to the commencement of development;
- Assisted rehabilitation will be required if understorey response is minimal, (selected replanting of shrubs and seeding if feasible) especially in treeless areas;
- Low intensity thinning of dense stands of young trees to be applied in a small-scale mosaic pattern if carefully designed to have ecological benefit. Growth and stand structure response to be monitored. Draft protocols for such thinning are provided in Appendix A (Thinning is not a required action, but should be applied if judged to be beneficial).

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9. Appendices

Appendix A. Department of Planning Offset Recommendations - 8 December 2006

Your Reference : 20017605: C058
Our Reference : DOC06/xxxx
cc : Armidale Dumaresq Council
Contact : Todd Soderquist, 6773 7006
Date : 8 December 2006

Mr Chris Wilson
Major Development Assessment
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Attn: Mr Brad Deane

Dear Mr Wilson

OFFSET PROPOSAL – ARMIDALE REGIONAL LANDFILL

As you are aware, the Regional Landfill proposed by the Armidale Dumaresq Council will have detrimental impacts upon threatened species and communities. The Council has requested that the Department of Environment and Conservation (DEC) provide guidelines on how to offset these impacts. Mr Deane has previously advised the Council's consultants that they may work directly with the DEC in developing offset guidelines specific to the landfill. This letter outlines the results of these early discussions and is being provided to both the DOP and Council.

On 8 November 2006, Dr Todd Soderquist DEC Senior Threatened Species Officer, conducted a site inspection of the proposed landfill site with Mr Col MacIver from the Council and EA Systems consultants Mr Martin Dillon and Dr Liz Broese. Dr Soderquist assessed habitat quality and management requirements in the vicinity of proposed landfill, including surrounding areas that that have been suggested by the Council as potential offset areas. On the basis of this inspection and information provided by EA Systems, the DEC provides the following advice on actions to maximise the environmental outcomes of offsets to the proposal. The DEC may support the Council's landfill proposal if it is satisfied with the offset proposal.

In order to assess the merits of proposed offsets against general principles outlined in Attachment A, the DEC requires information on both the anticipated impact and the offset. Attachment B sets out a range of criteria that the DEC considers to be the minimum necessary to evaluate the offset, and in this case, define the biodiversity values of impacted areas and candidate offset area(s). Particular attention is needed to the potential application of management actions in Section 7. Some of the criteria relate specifically to the landfill site (e.g. transfer of logs) while others are generic and relevant to the design of any offsetting initiative. For each criterion in the table, we have described the DEC's preferred outcome and attached notes on the information needed.

A. Specific Issues for the Council

1) On-site actions: Avoid, Minimise, Rehabilitate

The development proposal should address the need to avoid impacts if possible, minimise those that will occur and rehabilitate each cell of the landfill as it is completed. For example, the *Soil Conservation Act* requires the proponent to rehabilitate the landfill site to stabilise and recreate a landscape that is compatible with the surrounding land and comparable to pre-existing land use.

The objective is to minimise future maintenance requirements by, among other actions, minimising soil erosion and consequent sedimentation of the surface drainage system. The science guiding rehabilitation/stabilisation of mine sites is considerable and should generally apply to landfill site rehabilitation. Evidence from current best practice management demonstrates that it is economically feasible and practical to stabilise soils and the landscape.

2) Offsite: Offsetting Impacts to Biodiversity

There has been increasing pressure to restore landscapes to minimise long term social cost and clearly establish measurable rehabilitation objectives that demonstrate sustainability. However, it would be erroneous to equate rehabilitation and stabilisation of a landfill site with the re-instatement of pre-disturbance biological diversity and natural ecological processes. Creating geomorphologically stable landscapes during rehabilitation does not ensure re-establishment of the complexity and diversity of natural ecosystems, especially where the loss of older trees will require centuries to replace. Restorative practices are only now developing, the cost is significant and the long-term success is uncertain.

Consistent with the *EP&A Act, TSC Act* and *NP&W Act*, the proponent of any development is obliged to avoid natural and cultural features to the greatest extent possible. No definitive experience or historical evidence exists to assure us that pre-disturbance 'naturalness' and biodiversity levels can be re-established following landfill construction. Nor is there any empirical information enabling us to gauge the rate at which biodiversity might recover.

Nevertheless, it is clear from the nature of landfilling that impacts to biodiversity are intense and that they will span time scales that are at least inter-generational, if not permanent. Furthermore, the losses that will occur at the landfill site also contribute to the already significant level of cumulative loss that has occurred at a regional scale on the New England Tablelands.

The only meaningful way to counter the direct impacts to biodiversity on the landfill site and to avoid adding to the cumulative loss at regional scale is to take actions to remove threats to or 'enhance' biodiversity at another site. Offsetting is a means by which we can narrow the biological shortfall between a rehabilitated (stabilised) landscape and a pre-disturbance landscape. Put another way, the biological debt incurred on-site can be remedied by a closely comparable credit (or better) off-site.

3) Defining an Appropriate Offset

Damage to biodiversity from the landfill will be immediate yet most management actions are expected to compensate for biodiversity loss only with gradual improvements. The New England Tablelands is a highly modified province and the DEC is concerned to ensure that, as far as possible, future developments take action to address cumulative impacts over both space and time. The information requested in the attached table should provide DEC with sufficient information to enable it to evaluate the merits of candidate offset areas.

The criteria in Attachment B vary in nature considerably. The DEC fully recognises that the values pertaining to one criterion are not directly or empirically 'comparable' with those of another criterion. Further, the DEC understands that it may not be possible, feasible or practical for the proponent to satisfy the DEC's preferences in terms of all criteria within one land parcel. In order to address one criterion well, compromises may need to be made to one or more others.

The DEC will evaluate the overall merit of an offset proposal having considered all criteria collectively. Importantly, the approach adopts a systematic assessment process and confers transparency for defensible decision-making.

As a guide to the size of offsets required, the Biometric Tool used in Property Vegetation Planning within NSW applies ratios for many threatened species on the order of 20:1 for offset to impact area. Logically there would be little reason to vary these ratios across proposals. In this instance there is potential for intensive management of offsets that might greatly improve the biodiversity contribution of these areas. From that perspective, if suitable management effort is incorporated in the proposal, an offset ratio of 3:1 or greater may be appropriate for the landfill.

4) Information Required from Armidale Dumaresq Council

High levels of detail are not necessary when addressing topics in Attachment B. Photographs with expert field observations will be sufficient for the DEC to form a view. For example, full species lists are not required. In completing the table DEC requests:

a) The Council to address each of the criteria with information for both the landfill area and the proposed offset area(s).

b) The Council simply describes impacted and offset areas under consideration, not evaluate the merit of the offset proposal to biodiversity in great detail.

If you wish to discuss any matter raised in this letter please ring Todd Soderquist in the Armidale office on 6773 7006.

Yours sincerely

Simon Smith
Manager Armidale Region
Environment Protection and Regulation Division
Department of Environment and Conservation

Attachment A

Offset Principles for Biodiversity Conservation Offsets under the Environmental Planning and Assessment Act, 1979

1. Introduction

The Department of Environment and Conservation is the agency legally responsible for biodiversity conservation across the state. There continues to be pressure on natural values from urban, industrial and agricultural development. As a consequence of past land-use decisions, a pressing short-term challenge is to secure and manage the larger, more intact landscape remnants so that fragmentation does not increase and natural values are not further diminished. In the longer term, the challenge for biodiversity is to rebuild landscapes that are ecologically viable for native species at all scales. Without mechanisms such as policy frameworks, this loss is likely to continue at a greater rate and in a less managed fashion.

The Environmental Planning and Assessment Act (EP&A Act) 1979 is the principal instrument in NSW governing land use planning and development control. Its objects include a commitment to ecologically sustainable development and to the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats. More broadly, the NSW Government has made a commitment to prevent further broad scale clearing of native vegetation, recognising that too much has been cleared in parts of the State with very serious environmental consequences.

Continued development and the inevitable expansion of urban and coastal settlement, in particular, will involve unavoidable loss of natural and semi-natural areas through land use change into the future. Developers have for some years offered to protect or transfer unaffected lands to other agencies or councils to compensate for environmental impacts.

The use of formal "offsets" schemes has emerged as a potentially feasible option when dealing with a wide range of development impacts. The NSW Government has already released discussion papers on *"Green Offsets for Sustainable Development"*[1], *"Offsets, Salinity and Native Vegetation"*[2] and *"Compensatory Wetlands."*[3]

In all of these publications, offsets are employed as a last resort after other methods to avoid, minimise and mitigate impacts have been considered. It is only one tool that can be employed, in limited circumstances, as part of a mix of strategies to achieve conservation outcomes and manage loss.

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[1] NSW Government April 2002, Green Offsets for sustainable development: Concept paper NSW Environment Protection Authority, NSW Department of Land and Water Conservation, NSW National Parks and Wildlife Service, Planning NSW

[2] NSW Department of Land and Water Conservation (2001),Offsets, Salinity and Native Vegetation: Discussion Paper , NSW Department of Land and Water Conservation, Sydney [http://www.dlwc.nsw.gov.au/care/salinity/pdf/offsets.pdf]

[3] NSW Department of Land and Water Conservation and NSW State Wetlands Advisory Committee (Nov 2002), Compensatory Wetlands: A discussion paper under the NSW Wetlands Management Policy, NSW Department of Land and Water Conservation, Sydney [http://www.dlwc.nsw.gov.au/care/wetlands/cw/cw.pdf]

2. What is an offset?

The term offsets refers to agreed actions that are undertaken to counter-balance the adverse impacts of approved development. In relation to biodiversity, offset actions provide a mechanism to compensate for loss of biodiversity values in one area by action elsewhere.

Benefits for biodiversity management may be achieved in three ways:

1. Securing protection of other, existing areas of equivalent conservation value. Habitat loss is one of the key threats to biodiversity. The permanent securing of areas of biodiversity value is an important gain, particularly if the area is also under threat.

2. The enhancement of existing habitat. This may include better management of existing habitat, assisted regeneration of degraded habitat, fencing and pest and weed control. This approach can increase the viability of existing remnants and needs to be considered in a regional context.

3. The protection of cleared land and the restoration or reconstruction of habitat. This involves high risks and uncertainties for biodiversity outcomes. This approach might be used strategically to link areas of high conservation value or to increase buffer zones around areas of high conservation value.

In most regions, preference is likely to be given to the first approach. That is, as a general rule the priority for offsets should be given to the protection, and enhancement if necessary, of threatened areas of equivalent biodiversity value to the impact area.

The enhancement of habitat in poor condition and habitat reconstruction would typically be undertaken where this would buffer high value habitat, or provide connectivity. Priority for these kinds of offsets may be higher if they are part of a landscape/regional habitat strategy. Where the only available habitat for some threatened species or endangered ecological communities is degraded, restoration and protection can also become a high priority.

3. Objectives of biodiversity offsets

1. To encourage well designed development proposals that take full account of all potential impacts.
2. To minimise loss through consideration of options to avoid or minimise biodiversity loss or mitigate biodiversity damage, and only use offsets to compensate for unavoidable biodiversity impacts as a last resort.
3. To use offsets to secure, protect and manage areas of significant biodiversity value into the future.
4. To take account of the potential contribution of different management and restoration actions in developing an offset proposal.
5. To calculate the area required for an acceptable offset according to the relative conservation values and condition of the impact area and offset area(s) (i.e. the ratio will vary depending on the relative values).

4. Principles of biodiversity offsetting

1. Offsets are only used to address residual impacts following consideration and implementation of options to avoid, minimise and mitigate impacts.

2. Offsets should be based on an agreed understanding of the conservation significance of the impact and offset values.
3. Offsets should maintain or improve identified biodiversity values secured into the future.
4. Offsets should be based on a "like for like" basis.
5. Offset area should be greater than the area impacted.
6. Offsets should generally be in proximity to the area impacted.
7. Offset actions should be located in areas of strategic regional conservation value where Principle 6 does not apply.
8. Offsets should be in addition to existing initiatives.
9. Offsets should minimise ecological risks from time lags.
10. Offsets should be secure, long term and auditable.

In applying these principles to an offset package, not all principles will be of equal relevance in all circumstances. The priority for each principle will depend on the regional conservation and development context, the nature of the identified biodiversity impacts of the development, the availability of offset options, the long-term management options for offset land and the relative likelihood of success of any option in the circumstances. For example, there may be circumstances where the "like for like" and "proximity" principles are given a lower priority in order to achieve strategic, targeted, viable and secure offset actions at a regional or vegetation community level.

Any trade-off between these principles should be considered in the context of the cumulative effects and any targets for biodiversity in a strategic regional context. The long term impact development and the use of offsets on other than a "like for like" basis should not result in the depletion of particular species or communities to the point where their persistence is put at risk.

The agreed offset package for any development proposal should explain the priority given to each offset principle in a clear and transparent fashion.

Principle 1: Offsets are only used address residual impacts following consideration and implementation of options to avoid, minimise and mitigate impacts.

Offsetting should only be utilised as a last resort after all other options to avoid, minimise and mitigate impacts have been considered and deployed. Offsets address the residual impact following this process.

This process can be expressed succinctly as follows:

- <u>Avoid</u> impacts and retain biodiversity with priority for retention of habitat, which is of identified high conservation value and in good condition. This can be achieved through sensitive design and development planning.
- <u>Minimise</u> impacts where unavoidable. One way to minimise impacts is to reduce the size of the area to be impacted.
- <u>Mitigate</u> impacts to reduce the short, medium and long-term effects. The impacts on biodiversity need to be managed by implementing design, operational or organisational safeguards or controls such as exotic species management, erosion and sediment control, design innovation and rehabilitation of disturbed areas.

Where it can be demonstrated that no suitable development alternative exists, all prudent and feasible options have been examined and the development is deemed to be of sufficient community benefit to proceed, an agreed biodiversity offset package can be provided. This offset package should be developed and implemented to address the residual impacts that are agreed to be justified and unavoidable.

Principle 2: Offsets should be based on an agreed understanding of the conservation significance of the impact and offset values.

Consideration of offsets should only proceed following a comparison of the biodiversity significance of the impact and offset areas, based on the best available information and ecological principles.

It is important that there is an agreed understanding of the minimum level of data required and the methods to obtain this data. The level of risk and the dynamics of the natural system also need to be identified in developing offset options. It is essential that uncertainties arising from sparse ecological data and incomplete knowledge of species responses over time are taken into account in ranking or assessing options. It is also important that the potential risks to an offset option, for example from offsite threatening processes and climate change, are considered.

Principle 3: Offsets should maintain or improve identified biodiversity values secured into the future.

Offsets seek to compensate for the loss of biodiversity due to a development impact by maintaining or improving biodiversity values away from the impact area. The balance between loss and gain may be calculated according the conservation significance of the impact and offset areas and the likelihood of the persistence of the values to be protected as an offset. Offsets options will vary according to the biodiversity values of what is lost and the values, future viability and security of the offset option.

To achieve this outcome it is essential that the nature of the loss is clearly defined, the predicted secured benefits from offsetting are clearly identified and the means by which they will be delivered is legally agreed as part of the consent process prior to any works commencing.

Principle 4: Offset should be based on a "like for like" basis

1. Biodiversity losses must be offset with biodiversity gains. Biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity requirement. Benefits cannot be traded across types. For example, salinity benefits cannot offset biodiversity losses.

2. Preference in selecting offsets must be given to protecting areas that are of the same vegetation and habitat type and conservation significance as those being impacted within the regional context. This principle recognises that offsets should contribute to the long-term retention and recovery of habitat types and species depleted through development. The risk otherwise is that some habitat types will be substantially cleared, and therefore put at risk of at least regional extinction, in exchange for the protection or revegetation of other types.

3. Where there is no available "like for like" offset of reasonable size or viability, consideration should be given to protecting communities that are under a similar level of threat in strategic targeted areas (see principle 7), or to restoration of degraded areas of similar habitat type or reconstruction of habitat. These mechanisms can increase the viability of existing remnants, provide connectivity between areas of high conservation value or increase buffer zones around areas of high conservation value.

However, offsets should not be used when "like for like" is not possible **because** the development places the continued persistence of a species or community at significant risk of extinction by removing one of the last refuge areas for the species or community. Other mechanisms should then be invoked to avert the risk, for example, conditioning consent to require ex-situ conservation actions as a mitigation of impact.

Principle 5: The offset area should be greater than the impact.

The destruction of habitat or removal of native vegetation must be counter-balanced by offset areas greater than the area impacted. The greater area counters, to some extent, the risks and uncertainties associated with offsetting. The exact offset ratio to be applied will depend on the circumstances of the case. Knowledge of the total surviving extent of the habitat or vegetation type(s) involved, its historical depletion and the area that will be removed by the development are crucial considerations in relation to the viability of the offset.

Where an offset is proposed that is of poorer habitat condition than the vegetation cleared, a higher offset area ratio is justified, on the basis that good condition, essential to future sustainability, is difficult to recover. The highest ratios should apply for the revegetation of cleared land to account for the considerable timeframes and risks associated with revegetation. More than one offset location may be required to compensate for several impacted species or to compensate adequately for a single species.

Principle 6: Offsets should generally be in proximity to the area impacted

To ensure equity in the sharing of the impacts of development and the benefits of offsets, it is preferable that offset measures be provided in reasonable proximity to the areas impacted. There are a number of reasons for this:

- Applying the offset locally minimises the risk that any one area receives an unreasonable burden of impacts without receiving any benefits that offsetting can provide;
- Retaining habitat across its natural range spreads the risk of loss from catastrophic events such as fire;
- Protecting local populations may contribute to the conservation of genetic diversity.

Suitable boundaries for offsetting will vary. In rural areas, suitable areas may be subregions within bioregions. In urban areas, local government areas may be more appropriate. For very specific values such as particular threatened species, the offset boundary may be the natural distribution of the species involved.

Practical considerations such as the availability of suitable offset areas, viability and security may also affect the offset package. In some cases, a better conservation outcome that satisfies the other offsetting principles may be achieved by considering offset options over a greater distance from the impact. Strategic outcomes may take priority over proximity in these circumstances.

Principle 7: Offset actions should be in areas of strategic regional conservation value where like for like is not available in proximity to the impact

Where "like for like" cannot be achieved in proximity to the impact, biodiversity offsets may be targeted to achieving protection of those areas of significant vegetation that are at most risk or less secure in the locality, or those areas that have most strategic conservation value in an intensively modified region. For example, in highly developed regions, there may be very few large areas of any natural vegetation type remaining. The priority for offsetting actions could be directed to enhancing the status of remaining viable species or communities or protecting any large viable patches of habitat that are rare and at risk of loss and fragmentation.

Principle 8: Offsets should be in addition to existing initiatives

Offsets should not utilise areas where public funds are already being applied for conservation and management eg. Landcare restoration projects and revegetation of council reserves. Offsets can be used to expand and complement these existing conservation programs provided there is well documented and transparent accounting to ensure there is no double accounting.

Offsetting is generally not appropriate on public land, as there are existing statutory responsibilities for public authorities to manage heritage values. Offsetting should not generally be used to supplement the budgets of public land management authorities.

Principle 9: Offsets should minimise ecological risks from timelags

Any time lags between removing and replacing habitat function should be factored into the specification of offsets (for example where mature paddock trees are replaced by new plantings). These may range from initiating offsets well prior to impact to initiating offsets as soon as practicable, but with the risks involved to biodiversity factored into the location, replanting ratio and total area of the offset proposal.

Principle 10: Offsets should be secure, long term and auditable

Offset strategies must be demonstrated to be secure and their conservation values should be evident within an acceptable timeframe. The legal and administrative arrangement that bind an offset must be clear and binding in perpetuity with penalties for non-compliance (see point 5 for suggested mechanisms).

Mandatory documentation (a Register) of offset agreements should convey full details about all locations and actions involved in an agreement. A spatial record on a centralised GIS spatial database, managed by DEC and accessible by DEC officers, is also required. These records ensure that details of offset agreements are not lost over time and future development proposals do not reverse any gains. They are also a vital tool for monitoring compliance with the agreed terms of an agreement and the success of conservation outcomes.

Requirements for ongoing monitoring and evaluation, as well as technical specifications for the work, should be factored into the offset agreement. It may be appropriate that the developer funds the first 5-10 years of monitoring to ensure that the intent of the agreement is being met. After a period, the responsibility could rest with local or state government and for the landholder.

5. Mechanisms to achieve security

A major obstacle to securing conservation outcomes is uncertainty regarding future ownership and management of lands agreed to be set aside from development ie. the offset site.

The preferred mechanisms to achieve security are:

- *Acquisition of land* with transfer to a public authority for ongoing management eg. Council, NPWS or Trust. This provides the most secure option for offsets but may be limited given the ongoing resourcing implications unless financial contributions are also negotiated.

  In the case of DEC, there are only certain types of lands that would qualify for reservation under the provisions of the NPW Act 1974. In general, preference is given to lands that meet state-wide conservation priorities; contain high conservation value vegetation; have threatened species habitat values; demonstrate corridor opportunities; have suitable size and boundary configuration; have regional recreation or open space values and are supported by adequate management funding (whether from private or public sources).

Council management would also require some ongoing commitment for establishment and operational costs to ensure that the costs of offsetting the impacts of a development are not simply transferred from the proponent to the community.

- *Conservation covenants on private land*. Conservation agreements exist under the *National Parks and Wildlife Act,* 1974, the *Nature Conservation Trust Act, 2001,* as well as appropriately worded s88B covenants under the *Conveyancing Act* 1919 where the benefiting authority is either the council or the DEC.

  A covenant restricts or prohibits activities that could degrade the environmental value of the land; is permanent and registered on the title to the land and is approved in writing by, or is entered into under a program approved in writing by a government authority. Conservation covenants may be eligible for concessional tax treatment and for other financial assistance (eg. Rate exemptions).

Less secure mechanisms need to be employed with caveats to ensure protection in perpetuity. They will generally be less attractive as offset options where more secure commitments are possible.

- *Wildlife Refuges, under the National Parks and Wildlife Act 1974,* can also be registered on the title deeds of the land for information purposes, but can be rescinded by the landowner or occupier at any time and are not secure.
- *Conservation zoning and development controls*. This refers to land use zoning in the Local Environment Plan (LEP) that identifies biodiversity protection and management as the primary objective and use of that land. The disadvantage of this mechanism is that the zoning can be changed at some later date without reference to original offset agreement. This mechanism should include a caveat in the LEP that requires referencing to the Minister responsible for conservation if there is a proposed change in the zoning of offset land.
- *Stewardship payments for development controls*. This basically provides incentives for a period of time to landowners to manage the conservation values of their land. However, security in perpetuity is not assured. If accompanied by a covenant or long-term (i.e. 30 year) contractual commitment, these may still be attractive offset options.

Attachment B

Offset Criterion	DEC Preferred Outcome	Proposed Outcome (Proponent to complete these columns)	
		Landfill Site	***Offset Site(s)***
1. Area of Offset	Ratio of offset to impact greater than 3:1 to account for time-lags and uncertainty, i.e., instantaneous adverse impact on-site, *v.* long term, gradual improvement to condition/ biodiversity level in offset area. The offset must consider that the larger trees being cut down are irreplaceable within a century.	The landfill operational area will occupy 19.7 ha. This includes 12.7 ha of regrowth stringybark woodland and 6.5 ha of cleared grassland which will be progressively cleared over the lifespan of the facility.	A 3:1 offset to impact ratio will result in an area of 38 ha of stringybark woodland and 20 ha of cleared grasslands used as an offset.
2. Ecosystem Type	Ecosystems that are least represented in the current reserve network and subject to greatest threat of modification. Preferred ecosystems (including above) that occur in lower topographic positions and/or on more productive soils (volcanic soils, mid-lower slopes and alluvial flats).	The landfill pit will be placed in stringybark woodland with associated infrastructure (road, leachate ponds) in adjoining grasslands. Condition of both communities is low.	Regrowth stringybark woodland and grassland adjacent to the site, currently in a similar condition as the landfill site, will be used for an offset. Fencing, weed and pest control, and relocation of timber piles will improve the condition of the offset.
3. Landscape Context	Although it is typically preferable that the offset area be connected with other sizeable remnants of native vegetation, in this instance the DEC recognises the efficiency of purchasing and managing offsets that are contiguous with the landfill. Nonetheless, the concept of landscape connectivity should be applied as much as is feasible on a local basis. The DEC would expect woodland areas to the south and east of the landfill to be core portions of any offset design. Any proposal to connect these woodlands with the others would help the offset quality.	Little continuity currently exists between the patch of stringybark woodland and adjoining woodlands.	Fencing and regeneration of woodland in the proposed offset area to the east of the site would decrease the distance between woodland remnants by several hundred metres.

Offset Criterion	DEC Preferred Outcome	Proposed Outcome (Proponent to complete these columns)	
		Landfill Site	*Offset Site(s)*
4. Offset Consolidation and Potential for Future Growth	A single, sizeable offset is preferable to isolated and smaller offset areas, with potential for expansion into neighbouring lands (remnant vegetation) through voluntary creation of corridors under incentive programs. Benefits: 1. Ecological viability increases with size; 2. Management efficiency maximised and costs reduced; 3. Planning for future landfill expansion expedited and "certainty" increased.	The landfill site will be located in the centre of the existing woodland. Offset areas will surround the landfill in a connected remnant.	The offset will be one continuous remnant of 60 ha surrounding the proposed landfill pit and infrastructure.
5. Condition	Native vegetation with minor/nil disturbance, stable and productive soil surface condition and minor/nil weed invasion. Areas containing largely cropped lands are not considered to contribute highly as conservation offset.	All of the current landfill footprint area is highly disturbed with high numbers of fauna pests and weed invasion. Both the grassland and the woodland are currently used as grazing the land.	The proposed offset areas are similar to the existing landfill site and have been extensively grazed. Mitigation measures, including eradication of pests and weeds, and erecting fencing to exclude grazing will improve the condition of the offset area.

Offset Criterion	DEC Preferred Outcome	Proposed Outcome (Proponent to complete these columns)	
		Landfill Site	*Offset Site(s)*
7. Proposed Management	Commitment to removing/ minimising threats to biodiversity. Management actions include: 1. Clearing of trees on the landfill area is to progress only as the landfill is expanded on a cell by cell basis. 2. Domestic livestock are to be removed immediately after land purchase. 3. The offset areas are to be fenced with livestock proof and rabbit resistant fencing. 4. Exotic herbivores (goats, rabbits, pigs) are to be eliminated or controlled in the offset areas. Densities of rabbits are to be monitored closely and any irruption must be controlled immediately. Guidelines for control need to be developed. 5. Cat populations associated with the landfill are to be kept under constant control. 6. Control of foxes in the offset area is desirable, especially if part of a broader regional program with neighbouring properties. Localised control of foxes reliant upon the landfill is required. 7. Weeds are to be controlled at all times. 8. Hazard reduction burning in offset areas is not permitted. If hazard reduction burning is required as a buffer to the landfill, the design must minimize the area burned or preferably use slashing to achieve a narrow buffer. 9. Move hollow trees from landfill area to offset areas as logs or erect as stags if feasible. 10. Move all logs that are >20 cm diameter at any point off the landfill site to the offset area. 11. Rehabilitation of tree cover in selected areas should begin as soon as possible after stock removal. Monitoring of understorey response	1. Clearing of trees on the landfill area is to progress only as the landfill is expanded on a cell by cell basis. 2. The site is currently overrun with hundreds of rabbits and some foxes. 3. Exotic blackberry and hawthorn shrubs will be eradicated prior to construction in both the landfill and offset site. 4. Ongoing targeted monitoring and weed control of exotic grasses (Coolatai grass, African lovegrass, serrated tussock, Chilean needlegrass) will be implemented in areas subject to soil disturbance.	1. Domestic livestock are still grazing on the site, but will be removed prior to commencing construction. 2. The offset area will be fenced to exclude livestock. Construction of fencing to exclude rabbits and introduced predators will be erected around areas to be revegetated. 3. A control plan for rabbits, foxes and cats will be implemented. 5. Exotic blackberry and hawthorn shrubs will be eradicated prior to construction in both the landfill and offset site. 4. Ongoing targeted monitoring and weed control of exotic grasses (Coolatai grass, African lovegrass, serrated tussock, Chilean needlegrass) will be implemented. 5. Hazard control burning should not be required for the landfill. 6. Hollow logs and erect stags will be relocated from the landfill footprint to the offset area. These logs may be of highest value on the grassland community where dead wood is more scarce. 14. Rehabilitation of tree cover in selected areas will begin as soon as possible after stock removal. Monitoring of

		Proposed Outcome (Proponent to complete these columns)	
	to grazing removal should be initiated concurrently. 12. If understorey response is minimal, apply assisted rehabilitation (selected replanting of shrubs and seeding if feasible) especially in treeless areas. 13. Low intensity thinning of dense stands of young trees can be applied in a small-scale mosaic pattern if carefully designed to have ecological benefit. Growth and stand structure response needs to be monitored. Draft protocols for such thinning are provided in Appendix C. Thinning is not a required action, but should be applied if judged to be beneficial.		understorey response to grazing removal will be initiated concurrently. 7. If understorey response is minimal after 12 months of stock removal planting of shrubs and seeding will be implemented. 8. Dense regrowth in the far southern portion of the offset area may benefit from thinning. Thinning will be implemented as per Appendix C.
8. Permanency / Security of Offset	A. Secure dedication to conservation land use and management into perpetuity. Mechanisms include (but not limited to): • Ownership vested in Council, Land Trust or Bio-bank; • Formal Conservation Agreement (VCA under NPW Act) bound to title prior to on-selling; • Covenant on title. DEC prefers strongest form of dedication and highest level of protection from future disturbance over inter-generational timeframes. B. Area chosen is of nil or minimal potential for mineral prospecting.		The ownership of the proposed landfill site is vested in the Armidale Dumaresq Council.

Notes on Attachment B – Information required.

a) **Criteria 3, 4 and 5.**

Scanned aerial-photos showing both the impact areas and proposed offset area(s) would be preferable. These will facilitate assessment of the areas within the context of the broader landscape in terms of:

- surrounding vegetation remnants;
- connectivity to remnants;
- topographic position;
- configuration with respect to DEC estate; and
- potential for future growth of the offset area.

b) Criterion 2 (Ecosystem Type)

Describe vegetation, soils and topographic position. This does not need to deal with likely/known fauna or fauna habitat.

Photographs - of each area (impacted and offset area(s) showing topographic context and typical vegetation in each area. This would assist and complement written descriptions below.

Vegetation description
- Structure;
- Dominant floristics – 1-3 dominant plants of each vegetation stratum;
- Patterning – homogeneous through to highly variable. If patterning significant, describe various vegetation patches in area in terms of stuctures/floristics;
- Unique/rare or otherwise “special” vegetation features;
- Endangered Ecological Community.

Soils
- Parent geology
- Observed (not measured) soil colour and texture;
- Variability over area. If highly variable, describe range in colour and texture

Topography
- Topographic position
- Terrain element
- Slope – estimated
- Aspect

c) Criterion 6 (Condition)

Vegetation

- Disturbance - nature and extent (% of area) of in terms of clearing, grazing and/or cropping;
- Age structure – old growth, regrowth, mixture
- Weeds – species, degree of dominance and extent (% of area)

Soil

- Erosion features – (rills, gullies, sheet) extent (% of area), type and severity;
- Surface condition – litter and/or cryptogamic cover, organic matter incorporation, structure, friability/compaction.

Attachment C: Protocols for thinning of regrowth in the offset areas *DRAFT*

Thinning dense stands of small regrowth trees, if carefully designed, can assist biodiversity by returning a forest system to a natural structure more rapidly than is possible through natural attrition. The following guidelines for ecological thinning can be applied where it is judged by qualified ecologists that stands of small trees exist at unusually high densities.

Category	Guidelines
1. Site selection	Thinning should be applied only to localised areas that are dominated by trees less than 15 cm diameter at breast height (DBH). Thinning will not be applied to areas where basal area is less than 20 m^2 per ha.
2. Tree size	Only trees less than 15 cm DBH will be cut.
3. Area	A mosaic of thinning is required, with some areas left unthinned across the landscape. Each thinning operation will be conducted within a defined site of no more than 2 ha.
4. Percent of area	To further guide the creation of a mosaic, within the 2 ha defined site no more than 50% of the area will be thinned, preferably as small plots of less than 900 m^2 (30 X 30 m).
5. Basal area target	Thinning will be designed so that remaining basal area in the thinned plots is greater than 20 m^2.

Appendix B. Site Photos

Figure 5. Groundcover in Stringybark Woodland proposed landfill pit impact area

Figure 6. Groundcover in Stringybark Woodland proposed offset groundcover area

Figure 7. Dense regrowth in Stringybark Woodland offset area

Figure 8. Cleared grassland in proposed landfill pit impact area

Figure 9. Proposed landfill pit impact area in Stringybark Woodland. The area is dominated by mature regrowth with few remnant mature emergent trees.

Figure 10. Log piles in the Stringybark Woodland of the proposed landfill pit impact area

Figure 11. Blackberry shrubs (noxious weed) in the log piles within the Stringybark Woodland proposed landfill pit impact area

Appendix C. Flora Species Recorded On-Site

Table 1. Flora species observed in the study area on 3 April 2005, 15 October 2005 and 18 September 2006
V=Vulnerable Species (TSC act and EPBC Act); R=ROTAP species; TSR=Travelling Stock Reserve;
*= introduced species, **= exotic species listed as noxious weeds for the Armidale Dumaresq LGA.

Status	Scientific name	Common name	Study site	TSR
	Trees			
	Acacia filicifolia	Fern-leaved Wattle	✓	✓
	Allocasuarina littoralis	Black She-oak	✓	
	Banksia integrifolia subsp. *monticola*	Banksia		✓
	Angophora floribunda	Rough-barked Apple		✓
	Eucalyptus blakelyi	Blakelys Red Gum	✓	✓
	Eucalyptus bridgesiana	Apple-topped Box		✓
	Eucalyptus caliginosa	New England Stringybark	✓	✓
R	***Eucalyptus elliptica***	Bendemeer White Gum		✓
	Eucalyptus melliodora	Yellow Box	✓	✓
V	***Eucalyptus nicholii***	Narrow-leaved Black Peppermint		✓
	Exocarpus cuppresiformis	Native Cherry		✓
	Shrubs			
	Acacia dawsonii	Poverty Wattle		✓
	Acacia ulicifolia	Prickly Moses	✓	✓
	Bursaria spinosa subsp. *spinosa*	Blackthorn	✓	✓
	Cassinia laevis	Cough Bush	✓	✓
	Cassinia quinquefaria	Cough Bush	✓	✓
*	*Crataegus monogyna*	Hawthorn	✓	✓
	Cryptandra amara	Bitter Cryptandra		✓
	Cryptandra propinqua	Cryptandra		✓
	Daviesia genistifolia	Broom Bitter Pea	✓	✓
	Daviesia latifolia	Broad-leaved Bitter Pea	✓	✓
	Dillwynia sieberi	Spiny Parrot Pea		✓
	Grevillea juniperina	Juniper-leaved Grevillea		✓
	Hibbertia linearis	Guinea Flower	✓	
	Hibbertia obtusifolia	Guinea Flower	✓	✓
	Hibbertia riparia	Guinea Flower	✓	✓
	Hovea linearis	Hovea		✓
	Indigofera australis	Hill Indigo	✓	✓
	Jacksonia scoparia	Dogwood	✓	✓
	Lespedeza juncea subsp. *sericea*	Chinese Lespedeza		✓
	Lissanthe strigosa	Peach Heath	✓	✓
	Maytenus silvestris	Narrow-leaved Orangebark		✓
	Melichrus urceolatus	Urn Heath		✓
	Olearia viscidula	Sticky Daisy Bush		✓
	Phyllanthus virgatus	Small Spurge	✓	

Status	Scientific name	Common name	Study site	TSR
	Pimelea curviflora var. *divergens*	Curved Riceflower	✓	✓
	Pultenaea microphylla	Spreading Bush-Pea	✓	✓
**	*Rosa rubiginosa*	Sweet Briar	✓	✓
**	*Rubus fruticosus* s.l.	Blackberry	✓	✓
	Rubus parvifolius	Native Raspberry	✓	✓
	Vines/climbers			
	Glycine clandestina	Glycine	✓	✓
	Glycine tabacina	Variable Glycine	✓	✓
	Hardenbergia violacea	Purple Twining-Pea		✓
	Mistletoes			
	Amyema micquelii	Mistletoe		✓
	Amyema pendulum	Drooping Mistletoe	✓	✓
	Grasses			
	Aristida ramosa	Purple Wiregrass	✓	✓
	Aristida vagans	Wiregrass	✓	✓
	Austrodanthonia laevis	Wallaby Grass	✓	✓
	Austrodanthonia racemosa var. *racemosa*	Slender Wallaby Grass	✓	✓
	Austrodanthonia richardsonii	Wallaby Grass	✓	
	Austrostipa rudis	Tall Speargrass	✓	✓
	Austrostipa scabra subsp. *scabra*	Rough Speargrass	✓	✓
	Bothriochloa decipiens	Red-leg Grass	✓	
	Bothriochloa macra	Red-leg Grass	✓	✓
*	*Briza minor*	Quivering Grass	✓	
	Chloris ventricosa	Tall Chloris	✓	
*	*Chloris virgata*	Feathertop Rhodes Grass	✓	
	Cymbopogon refractus	Barb-wire Grass	✓	✓
	Cynodon dactylon	Couch	✓	
	Dichelachne micrantha	Slender Plume Grass	✓	✓
	Echinopogon caespitosus var. *caespitosus*	Hedgehog Grass	✓	✓
*	*Eleusine tristachya*	Goose Grass	✓	
	Elymus scaber	Wheat Grass	✓	✓
*	*Enneapogon nigricans*	Niggerheads	✓	
**	*Eragrostis curvula*	African Lovegrass	✓	✓
	Eragrostis leptostachya	Small Lovegrass	✓	✓
	Eragrostis molybdea	Lovegrass	✓	✓
	Lachnagrostis avenaceus	Blown Grass	✓	✓

Status	Scientific name	Common name	Study site	TSR
	Microlaena stipoides var. *stipoides*	Meadow Rice Grass	✓	✓
	Panicum effusum	Hairy Panic	✓	✓
*	*Paspalum dilatatum*	Paspalum	✓	
	Paspalum distichum	Water Couch	✓	
	Pennisetum allopecuroides	Swamp Foxtail	✓	
	Poa sieberiana	Snow Grass	✓	✓
*	*Setaria gracilis*	Pigeon Grass	✓	
	Sarga leiocladum	Native Sorghum	✓	✓
	Sporobolus creber	Slender Rat's Tail Grass	✓	✓
	Themeda australis	Kangaroo Grass	✓	✓
	Herbs			
	Acaena ovina	Sheep's Burr		✓
*	*Acetosella vulgaris*	Wood Sorrel	✓	✓
	Ajuga australis	Austral Bugle		✓
*	*Anagallis arvensis*	Scarlet Pimpernell	✓	✓
	Asperula conferta	Woodruff	✓	✓
*	*Aster subulatus*	Wild Aster	✓	✓
	Bidens subalternans	Greater Beggar's Ticks		✓
	Brachycome nova-anglica	New England Brachycome		✓
	Brunoniella australis	Blue Trumpet		✓
	Bulbine bulbosa	Bulbine Lily		✓
	Calotis cuneifolia	Purple Burr-daisy	✓	✓
	Calotis lappulacea	Tangled Burr-daisy	✓	
	Carex appressa	Tall Sedge	✓	✓
	Carex breviculmis	A Small Sedge		✓
*	*Centaurium erythraea*	Common Centaury	✓	✓
	Centella asiatica	Pennywort	✓	
	Centipeda minima	Spreading Sneezeweed	✓	
	Cheilanthes distans	Hairy Mulga Fern	✓	
	Cheilanthes sieberi subsp. *sieberi*	Poison Mulga Fern	✓	✓
	Chrysocephalum apiculatum	Clustered Everlasting	✓	✓
*	*Cirsium vulgare*	Spear Thistle	✓	✓
*	*Conyza bonariensis*	Flaxleaf Fleabane	✓	✓
	Craspedia canens	Grey Billy-buttons		✓
	Crassula sieberiana	Australian Stonecrop		✓
	Cymbonotus lawsonianus	Bear’s Ear	✓	✓
	Cynoglossum australe	Native forget-me-not		✓
*	*Cyperus eragrostis*	Umbrella Sedge	✓	✓
	Cyperus gracilis	Slender Sedge	✓	✓
	Cyperus lhotskyanus	Sedge	✓	

Status	Scientific name	Common name	Study site	TSR
	Cyperus sanguinolentus	Sedge		✓
	Cyperus sphaeroideus	Sedge	✓	✓
	Desmodium brachypodum	Large Tick-trefoil	✓	✓
	Desmodium gunnii	Tick-trefoil	✓	✓
	Desmodium varians	Slender Tick-trefoil	✓	✓
	Dianella revoluta var. *vinosa*	Flax Lily		✓
	Dichondra sp. A	Kidney Weed	✓	✓
	Dipodium sp.	Hyacinth Orchid		✓
	Diuris chrysantha	Donkey Orchid		✓
	Elatine gratioloides	Waterwort	✓	
	Eleocharis acuta	Spikerush	✓	✓
	Euchiton sphaericus	Cudweed	✓	✓
	Fimbristylis dichotoma	Common Fringe-sedge	✓	✓
*	*Gamochaeta spicata*	Spiked Cudweed	✓	✓
	Geranium solanderi var. *solanderi*	Native Geranium	✓	✓
	Goodenia hederacea subsp. *hederacea*	Ivy Goodenia	✓	✓
	Goodenia pinnatifida	Goodenia	✓	✓
	Haloragis heterophylla	Raspwort	✓	✓
	Hydrocotyle laxiflora	Stinking pennywort		✓
	Hypericum gramineum	Small St. John's Wort	✓	✓
*	*Hypochaeris radicata*	Catsear	✓	✓
	Hypolepis glandulifera	Downy Ground-fern	✓	
	Isolepis sp.	Small Clubrush	✓	✓
	Juncus filicaulis	Rush		✓
	Juncus planifolius	Broad Rush		✓
	Juncus sp.	Rush	✓	✓
	Juncus usitatus	Rush	✓	✓
*	*Lepidium africanum*			✓
	Leptorynchos squamatus	Yellow Buttons		✓
	Lomandra filiformis	Slender Mat-rush	✓	✓
	Lomandra longifolia	Spiny Mat-rush		✓
	Mentha diemenica	Pennyroyal	✓	✓
	Opercularia hispida	Hairy Stinkweed		
	Orchid - ground	unknown sp, rosette lvs		✓
	Oxalis exilis	Soursob	✓	✓
*	*Paronychia brasiliana*	Chilean Whitlow Wort	✓	✓
	Pellaea falcata	Sickle Fern	✓	
	Persicaria lapathifolia	Knotweed	✓	
	Persicaria prostrata	Spreading Knotweed	✓	✓
*	*Petrorhagia nanteulii*			✓
*	*Phytolacca octandra*	Inkweed	✓	

Status	Scientific name	Common name	Study site	TSR
	Plantago gaudichaudii	Slender Plantain		✓
*	*Plantago lanceolata*	Lamb's Tongue	✓	✓
	Podolepis sp.	Copper Daisy		✓
*	*Polygonum aviculare*	Wireweed	✓	
	Poranthera microphylla	A Euphorb		✓
	Ranunculus lappaceus	Common Buttercup		✓
	Ranunculus pumilio	Small Buttercup	✓	
	Rumex brownii	Swamp Dock	✓	✓
*	*Sanguisorba minor*	Salad Burnet		✓
	Scleranthus biflorus	Knawel		✓
	Senecio gunnii	A senecio		✓
	Stackhousia monogyna	Creamy Candles	✓	✓
*	*Taraxacum officinale*	Dandelion		✓
*	*Trifolium campestre*	Hop Clover	✓	
*	*Trifolium repens*	White Clover		✓
	Triptilodiscus pygmaeus	Small Sunray	✓	
	Typha orientalis	Broad-leaved Cumbungi		✓
	Urtica incisa	Stinging Nettle	✓	✓
*	*Urtica urens*	Stinging Nettle	✓	
*	*Verbascum thapsus*	Great Mullein	✓	
*	*Verbascum virgatum*	Green Mullein		✓
*	*Verbena bonariensis*	Purple Top	✓	✓
	Veronica plebeia	Trailing Speedwell		✓
	Viola betonicifolia	Native Violet		✓
	Vittadinia muelleri	Dissected Fuzzweed		✓
	Vulpia bromoides	Squirrel Tail Fescue		
	Wahlenbergia communis	Bluebell	✓	✓
**	*Xanthium spinosum*	Bathurst Burr	✓	
	Aquatic plants			
	Ottelia ovalifolia	Swamp Lily	✓	
	Vallisneria gigantea	Ribbonweed	✓	

AECOM

MORE SPECIALISTS,
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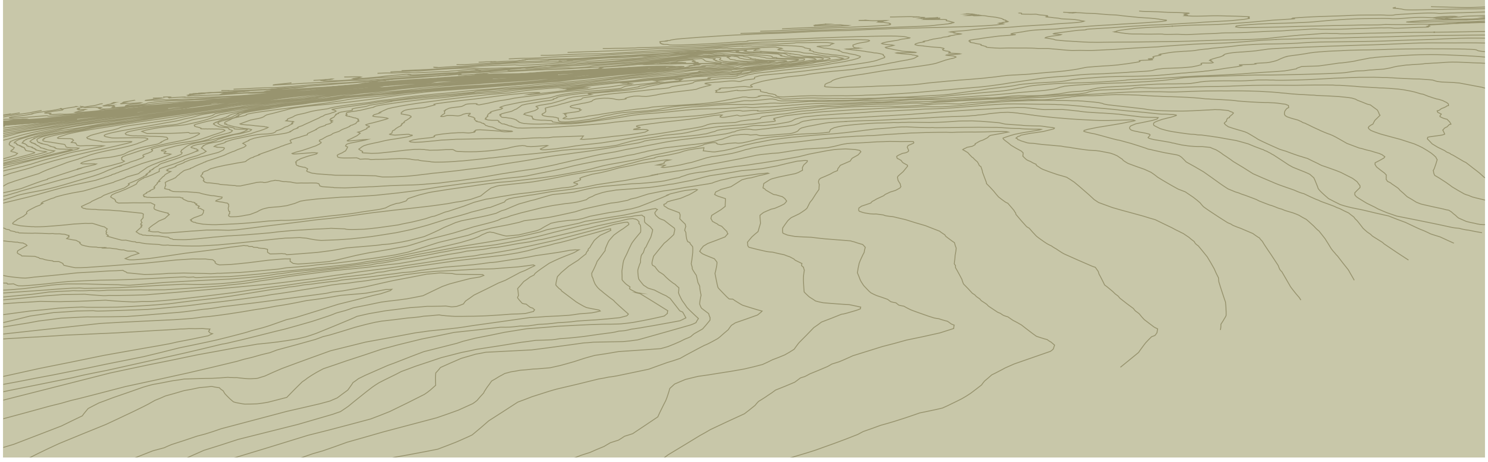
ARMIDALE REGIONAL LANDFILL

Environmental Assessment



ARMIDALE REGIONAL LANDFILL

Environmental Assessment Publications

Volume 1

Main Document

Volume 2

Appendix A	Director-General's Requirements, 2005 and 2008; and Government Consultation
Appendix B	AECOM, 2006: Armidale Regional Landfill Environmental Management Plan (Draft)
Appendix C	Maunsell AECOM, 2004: Regional Landfill Siting Study Final Report
Appendix D	EA Systems, 2006: Hydrogeological Study

Volume 3

Appendix E	EA Systems, 2009: Flora and Fauna Assessment
Appendix F	RCA Australia, 2007: Hydrogeological Investigation
Appendix G	AECOM, 2010: Landfill Concept Design Drawings
Appendix H	EA Systems, 2009: Biodiversity Offset Management Plan

Volume 4

Appendix I	AECOM, 2010: Landfill Liner Literature Review and Hydrogeological (Leachate) Assessment
Appendix J	NSW Department of Public Works and Services, 2002: Landfill Siting Study, Aerial Photographic Survey
Appendix K	EA Systems, 2006: Preliminary Contaminated Site Investigations
Appendix L	EA Systems, 2006: Salinity Assessment
Appendix M	PM Ashley, 2006: Geological Report on proposed Armidale Dumaresq Council landfill site, with emphasis on investigation of a possible geological fault
Appendix N	PM Ashley, 2005: Report on Geological Logging of Diamond Drill Core from the Proposed Armidale Landfill Site
Appendix O	Holmes Air Sciences, 2009: Air Quality Assessment Report
Appendix P	AECOM, 2010: Greenhouse Gas Inventory
Appendix Q	AECOM, 2010: Armidale Regional Landfill Noise Impact Assessment
Appendix R	Archaeological Surveys & Reports Pty Ltd, 2009: The Archaeological Investigation For Sites Of Indigenous Cultural Significance For Part 3A Approval New England Regional Landfill Waterfall Way, East of Armidale, Northern Tablelands NSW