

**BEVERLEY URANIUM MINE
ML 6321
and associated EMLs 6048-6052 inclusive**



**MINING AND REHABILITATION
COMPLIANCE REPORT
2009**

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GLOSSARY

ALARA	As Low As Reasonably Achievable
DITR	Department of Industry, Tourism and Resources (Commonwealth)
EC	Electrical Conductivity
ECL	Excursion Control Limit
EFA	Ecosystem Function Analysis
EL	Exploration Lease
EML	Extractive Minerals Lease
EMLA	Extractive Minerals Lease Application
EMS	Environmental Management System
EPA-RPD	Environment Protection Authority – Radiation Protection Division (State)
EPBC	Environment Protection and Biodiversity Conservation [Act] (Commonwealth)
FLT	Field Leach Trial
GA	General Atomics
ISR	In-Situ Recovery (previously referred to as ISL, In-Situ Leach)
MARCR	Mining and Rehabilitation Compliance Report
MARP	Mining and Rehabilitation Program
MC	Mineral Claim
ML	Mining Lease
MPL	Miscellaneous Purposes Licence
PIRSA	Primary Industry and Resources of South Australia
PLP	Pregnant Liquor Pond
SEB	Significant Environmental Benefit
UOC	Uranium Ore Concentrate

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1 INTRODUCTION

1.1 Context for this report

This report has been prepared by Heathgate Resources Pty Ltd (Heathgate) for its Beverley Uranium Mine (Mining Lease ML 6321) and associated Extractive Mineral Leases in general accordance with the “Minerals Regulatory Guidelines MG3 Guidelines for Miners: Preparation of a Mining and Rehabilitation Compliance Report (MARCR) Version 1.4 March, 2009” (PIRSA 2009).

Beverley Uranium Mine’s Mining Lease, ML 6321, incorporates the former ML 6036 and Miscellaneous Purposes Licences (MPL) 57, 58 and 59. The associated Mining and Rehabilitation Program (MARP) ADP2008/018 (Heathgate 2008b) was approved by Primary Industry and Resources of South Australia (PIRSA) on 7 October 2008 and the Australian Government Minister for the Environment and Water Resources on 13 November 2008.

This MARCR focuses on demonstrating that Heathgate has achieved environmental outcomes as required by the lease conditions of ML 6321 and the 2008 MARP. Heathgate’s EMLs are also included. The reporting period for this report is from 1 January 2009 to 31 December 2009.

1.2 Project proponent

Heathgate, which has its head office in Adelaide, South Australia, was formed in 1990 and purchased the Beverley project in 1990. Heathgate owns Wooltana Pastoral Lease (Wooltana Station) on which the Beverley Uranium Mine is located.

Heathgate is an affiliate of General Atomics (GA). GA (www.ga.com) was formed in San Diego, California, in 1955 to explore the peaceful uses of atomic energy. GA has had a long involvement in the nuclear fuel cycle including:

- Mining and processing of uranium
- Design of nuclear power stations and
- Development and implementation of technology to;
 - Eliminate hazardous wastes and
 - Convert warheads into electricity.

GA is also developing leading edge power generation techniques through a new generation of nuclear power plants using high efficiency gas turbines, similar to aeroplane jet engines, to generate electricity, and other non-nuclear enterprises.

Heathgate is also conducting uranium exploration on surrounding Exploration Leases (ELs), some held solely by Heathgate and some in joint venture with other companies. Quasar Resources, an affiliated company of Heathgate and similarly part of the GA group, is exploring on several nearby ELs held in joint venture with various other companies.

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1.3 Project Background

Heathgate acquired the Beverley leases in 1990 and undertook further evaluation of historic exploration data. In 1996 the company extended investigations with a view to establishing a mine at Beverley. Programs included baseline environmental studies, geological and uranium resource investigations, hydrogeological investigations and a field leach trial (FLT).

The FLT at Beverley operated under approvals given following a Declaration of Environmental Factors in 1997. The trial commenced in January 1998.

The first commercial uranium was produced in late 2000 and the mine was officially opened on 21 February 2001 by the then Deputy Premier and Minister for Primary Resources, the Honorable Rob Kerin MP and Mr Neal Blue, Chairman and CEO of Heathgate's parent company, General Atomics. Mining is undertaken using the in-situ recovery (ISR) method using an acidic and oxidising extraction solution, which is processed to uranium ore concentrate (UOC).

In accordance with Mining Regulations 42(b), all Mining Leases are subject to a requirement that operations are carried out in an orderly and skilful manner in accordance with an approved Mining Proposal and Mining and Rehabilitation Program (MARF). The current MARF (Heathgate 2008b) was developed directly from the approved Public Environment Report/Mining Proposal and Response Document for the extension of mining at Beverley beyond the initial Mining Lease (draft and final PER, Heathgate 2007, 2008a). It follows PIRSA Regulatory Guideline 2 (PIRSA 2007), as required by the lease conditions and feedback from stakeholders during the Mining Proposal submission and approval process. The MARF applies to all operations on ML 6321, including those on the former ML 6036.

Since the extension involves the mining of radioactive ore (uranium), licensing under the South Australian Radiation Protection and Control (RPC) Act 1982 also applies (Licence LM4). As the proposed action was designated as a "controlled action" under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (because of the Sections 21 and 22A - nuclear actions), approval for the extension project was also required from the Australian Government Minister for the Environment and Water Resources. The MARF also constitutes the approved Monitoring Plan, Mine Closure and Completion Plan and Community Engagement Plan that were required under this Federal Government approval.

Heathgate keeps accurate records of the quantity, value and manner of disposition of all minerals mined and, whenever required to do so by the Director of Mines or a delegate authorised by the Director of Mines, submits the records for inspection by the person so authorised.

1.4 Mining Lease Location and Land Tenure

Beverley (ML 6321) is located entirely within the Wooltana pastoral lease (Wooltana Crown Lease, Volume 1289 Folio 38) on the arid plains between the Northern Flinders Ranges and Lake Frome, approximately 550 km north of Adelaide and 300 km north-east of Port Augusta in South Australia (Figure 1-1).

Wooltana Pastoral Lease is Out of Hundreds and not within a District Council or Corporation area. The Outback Areas Community Development Trust provides services to the region that may otherwise be undertaken by a Council.

ML 6321 has an area of 117 km² although the majority of this remains undisturbed by mining apart from exploration activities. Mining until November 2008 had only been undertaken on former ML 6036 which had an area of approximately 5 km² (Figure 1-2).

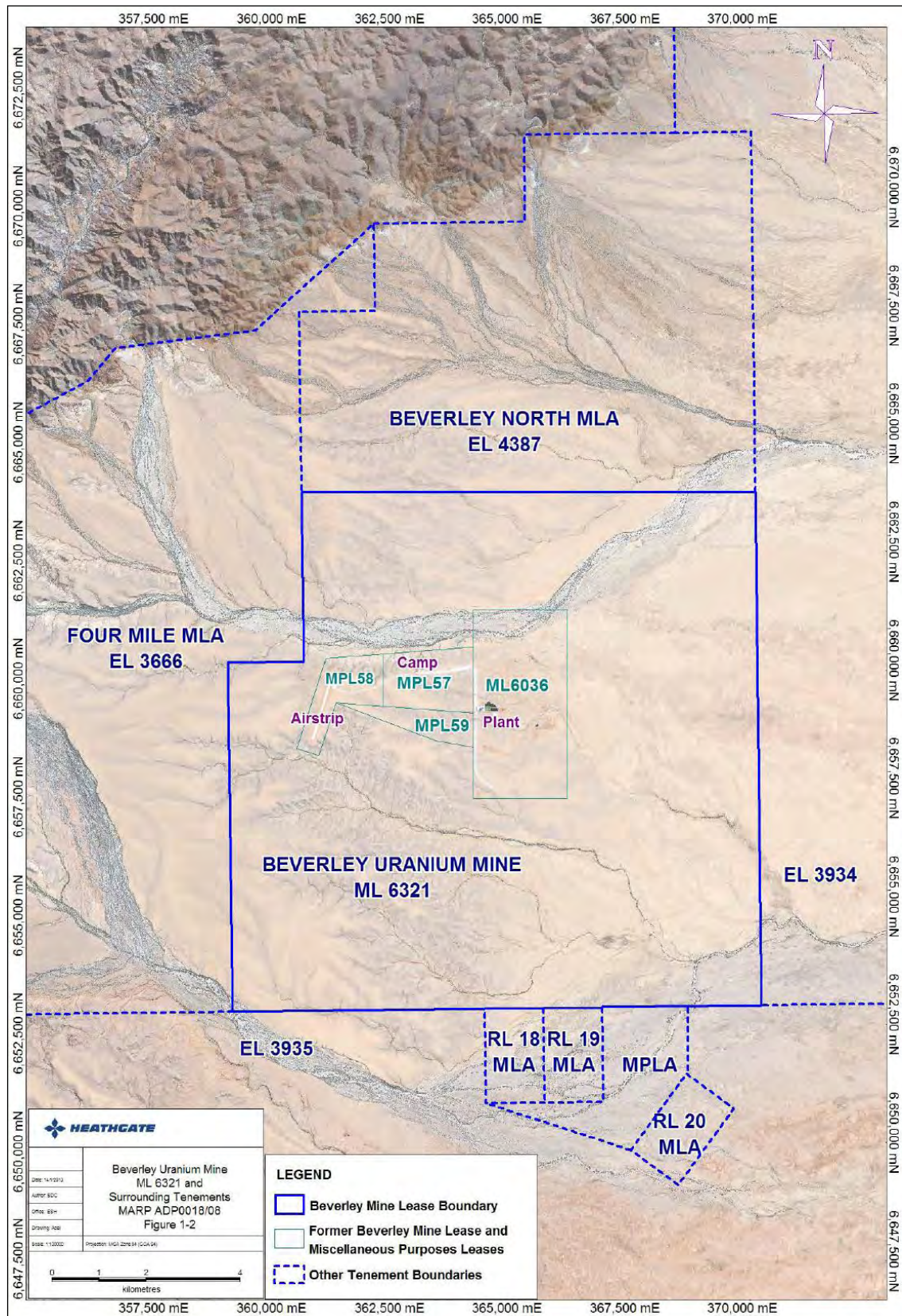
The closest communities include the tourist resort at Arkaroola in the Gammon Ranges National Park and the Aboriginal community at Nepabunna, approximately 30 km and 80 km to the south-west respectively.

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Figure 1-1: Beverley Uranium Mine – Location

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1.5 Heathgate Management Personnel

During 2009, the following Heathgate personnel were responsible for environmental management at the Beverley site:

- President – David Williams
- Vice President, Operations – Richard Phillips
- Environment, Safety & Health Manager – Dr Peter Woods
- Mine Manager – Gary Birch
- Production Manager, Plant – Chris Every
- Production Manager, Wellfield – Richard Borgas
- Senior Environment Advisor – Sue Carter.

1.6 Heathgate's Environment Policy

The latest version of Heathgate's environment policy is given below in Figure 1-3. This same policy applied to 2008 (changes to signatory and hence a date change occurred in 2009).



Figure 1-3: Heathgate's Environment Policy

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2 DESCRIPTION OF MINING ACTIVITIES

2.1 Activities

Beverley Uranium Mine owns and operates the Beverley Uranium Mine on ML 6321. ML 6321 was granted in November 2008 and this led to the approval of the 2008 MARP which incorporates similar environmental monitoring requirements as the Environmental Management and Monitoring Plan (EMMP) which applied to ML 6036 (now subsumed within ML 6321).

Delineation drilling and production drilling were conducted on the ML 6321 during 2009, none of which significantly affected the reserves or future production levels for the mine.

In 2009, mining activities occurred in the orebodies of North-East Wellfield, Central Wellfield, East Wellfield, South Wellfield and Deep South Wellfield and in the southern portion of the North Wellfield (refer Section 2.2).

Heathgate expects to be appointed operator of the nearby Beverley Four Mile project, a joint venture between Quasar Resources Pty Ltd and Alliance Craton Explorer Pty Ltd. This project is currently being assessed following the release of the draft PER/Mining Proposal (Heathgate 2009a) and Response Document (Heathgate 2009b). It is proposed to mine Beverley Four Mile as a satellite operation to Beverley ML 6321.

2.2 Wellfields

Six wellfields were established during 2009, in East, South and Deep South. Mining operations continued in North East, Central and South. In general, four to five wellfields are started up in any one year, and up until 2009 up to 10 wellfields are operated simultaneously. Table 2-1 Table 2-1: Wellfield activity during 2009 below shows which wellfields became active, which were turned off and which were active throughout the year.

Table 2-1: Wellfield activity during 2009

Wellfield	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C16 – Central	All year											
C21 – Central	All year											
S6 – South	All year											
S7 – South	All year											
NE3 – North East	All year											
S8 – South	7 Jan											
S5 – South	27 Feb											
E1 – East	19 Feb											
E2 – East	18 Mar											
E3 – East	17 Apr											
S3/S4 – South	19 Apr											
DG01 – Deep South	8 Jun											
DG02 – Deep South	7 Jul											
N6X	22 Jul											
No. of Wellfields	9	10	10	10	10	11	11	11	11	11	11	11

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Plate 2-1: A goanna (*Varanus gouldii*) emerging from beneath a cable tray that runs from the processing plant to the wellfields alongside the trunklines

2.3 Borrow Pits

Heathgate holds a number of Extractive Mineral Licences (EML) for construction minerals, mainly for use as road base. A map showing existing EMLs 6048-6052 inclusive together with Mineral Claims MC 3830, 4020 and 4131 is given in Figure 2-1. The resource to be extracted and the status of each of the EMLs and MCs are outlined in Table 2-2.

EML 6052 was rehabilitated in 2007 and long-lived perennial species including *Acacia* sp have begun to colonise the disturbed area as recorded by the EFA consultants during the 2009 survey and sighted by Heathgate personnel.

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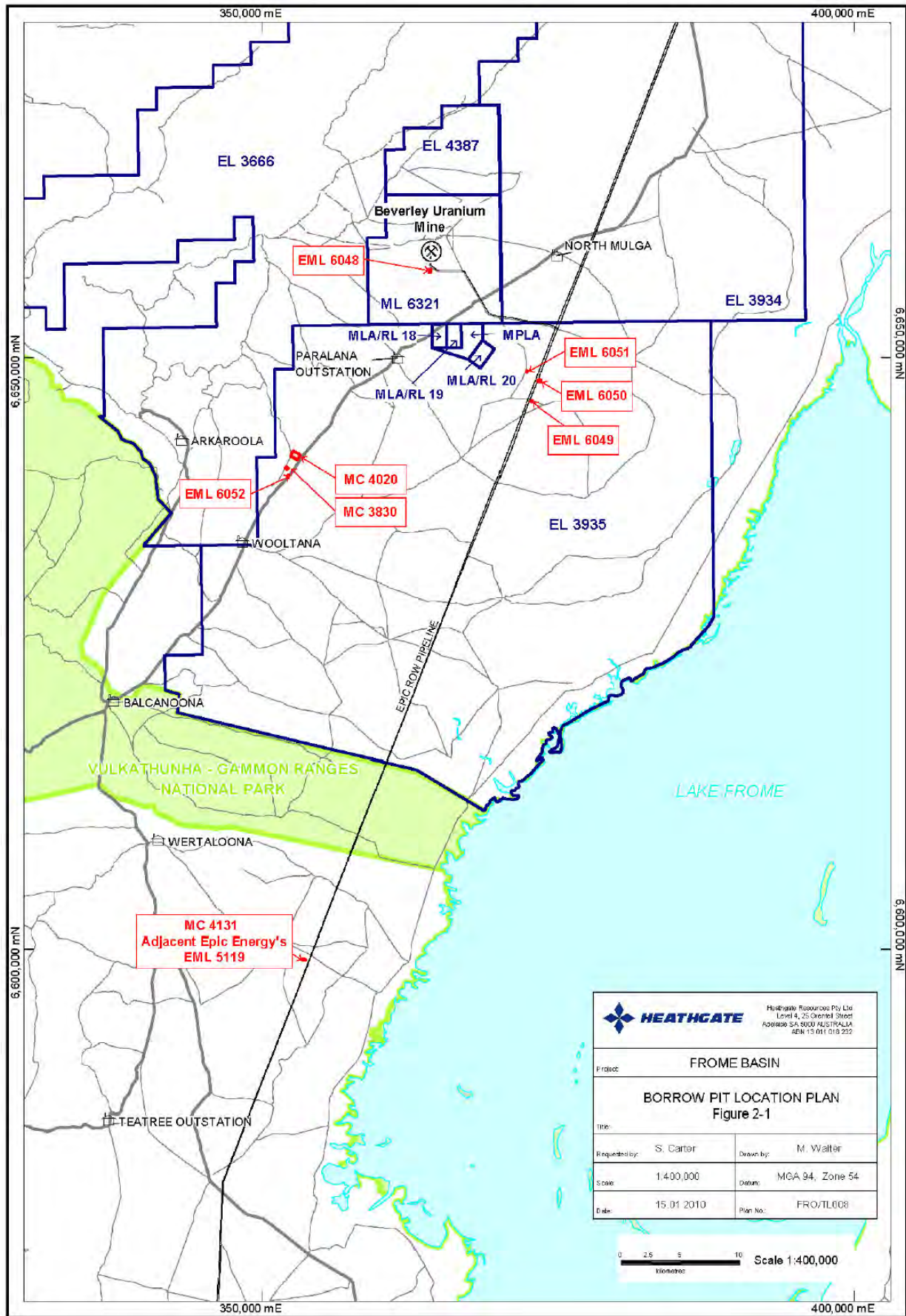


Figure 2-1: Borrow Pit Location Plan

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Applications for approvals for new calcrete pits are in progress. An Extractive Mineral Lease Application (EMLA) for Calcrete Pit 2 (Mineral Claim MC 3830), approximately 8 km north of Wooltana Station homestead and 22 km south-west of the Beverley Mine, was submitted in December 2007 and subsequently accepted in principle by PIRSA. Granting of the EML is expected when the relevant Native Title Agreement is registered, anticipated in mid 2009.

Heathgate applied for an EML over MC 4020 during 2009 and will apply for the same for MC 4131 adjacent to Epic Energy's EML 5119 during 2010. The EMLAs were and will be written in the form of a MARP and commit to annual reporting as part of the Beverley Mine MARCR series. The older EMLs do not require formal annual reporting, but will be commented on in the Beverley MARCR series.

Table 2-2: Status of Borrow Pits at end 2009

Tenement	Type	Status
EML 6048	Sand and gravel	In use – near mined out, used for storage of material and crushing and screening
EML 6049	Sand and gravel	In use
EML 6050	Sand and gravel	In use
EML 6051	Sand and gravel	In use (99% remaining)
EML 6052	Sand and gravel (Calcrete Pit 1)	Mined out and rehabilitated
MC 3830	Sand and gravel (Calcrete Pit 2)	EMLA accepted in principal, awaiting Native Title Agreement
MC 4020	Sand and gravel (Calcrete Pit 3)	EML applied for mid 2009, awaiting Native Title Agreement
MC4131	Sand and gravel (Calcrete Pit 4)	MC pegged March 2009, EMLA due mid 2010, awaiting Native Title Agreement

2.4 Changes to Operation

2.4.1 Processing Plant

Installation and commissioning of a new acid storage tank occurred in the latter part of 2009 after use of temporary acid storage tanks since the beginning of 2009 when the old tanks were decommissioned.

2.4.2 Mining in Deep South

Mining of Deep South began mid-year with installation of infrastructure commencing in the beginning of the year. The main trunklines to Deep South Wellfield were constructed with an engineered overpass of the natural gas pipeline after liaison with Epic Energy, and an engineered crossing of Mulga Creek.

2.4.3 Four Mile Construction Camp

Installation of the temporary Construction Camp occurred on ML 6321 to accommodate workers involved in the construction of the Beverley Four Mile Satellite Plant.

2.4.4 Cooling Towers

The cooling towers at the accommodation camp and the processing plant have been decommissioned and replaced with heat exchanger units to prevent the occurrence of *Legionella* bacteria.

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2.4.5 Ore Reserves and Mine Life

Exploration, delineation and production drilling occurred within the Mining Lease, ML 6321 during 2009. This drilling had no significant affect on the resource estimate.

Exploration and delineation drilling, conducted by Heathgate Resources, occurred on the adjacent Arkaroola EL 3666, in the Four Mile East and Four Mile West mineral prospects. Alliance Resources released a resource estimate for Four Mile East.

Exploration drilling occurred in Paralana EL 4387. Uranium mineralisation was intersected. Drilling is ongoing for resource definition.

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3 ENVIRONMENTAL AND SOCIAL COMPLIANCE ACTIVITIES

Compliance monitoring and management activities at Beverley are based around seven key risk areas identified in the MARP:

- Soil
- Vegetation
- Surface water
- Hydrogeology
- Fauna
- Air Quality
- Heritage.

This section discusses the monitoring requirements for these seven risk areas, interpretation of the data and their compliance status for 2009. A table of compliance monitoring is shown for each risk area in the following sections of this chapter.

Meteorological data has also been included in this chapter as this relates to several key risk areas (Section 3.1).

Table 6-4 of the 2008 MARP outlines potential impact events, risks, management, outcomes and measurement. The primary design and management measures are embedded within this table. Table 6-4 of the 2008 MARP is presented in Appendix A of this report.



Plate 3-1: Short-beaked Echidna (*Tachyglossus aculatus*) at Four Mile Creek

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3.1 Meteorological

Meteorological data is collected continuously at the Beverley site weather tower. Wind speed, wind direction and temperature data are collected at 3 m, 20 m and 28 m and recorded every 10 minutes using a continuous data logging system. Rainfall data is collected using a tipping bucket and recorded every 10 minutes.

An automated evaporation pan including precision water level meter and refill tank provide measurements of evaporation. Evaporation is logged at the same time on a daily basis. The weather station also contains a humidity sensor with humidity, logged every 10 minutes.

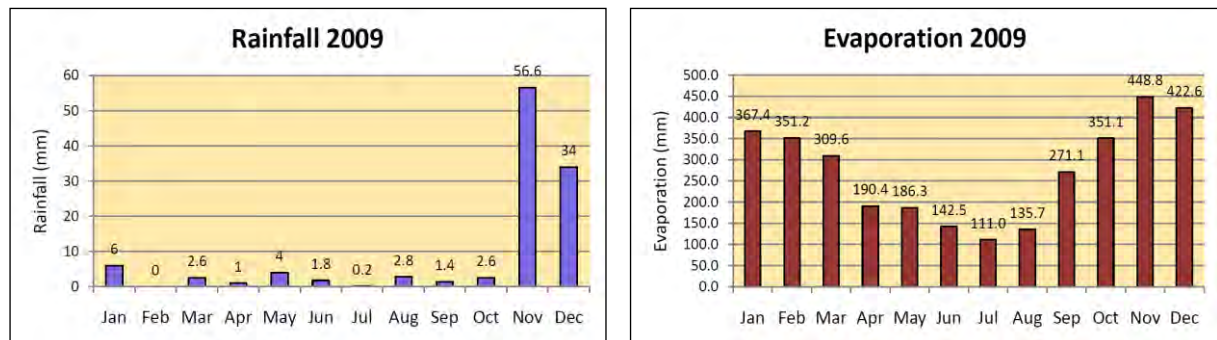


Figure 3-1: Monthly Rainfall and Evaporation

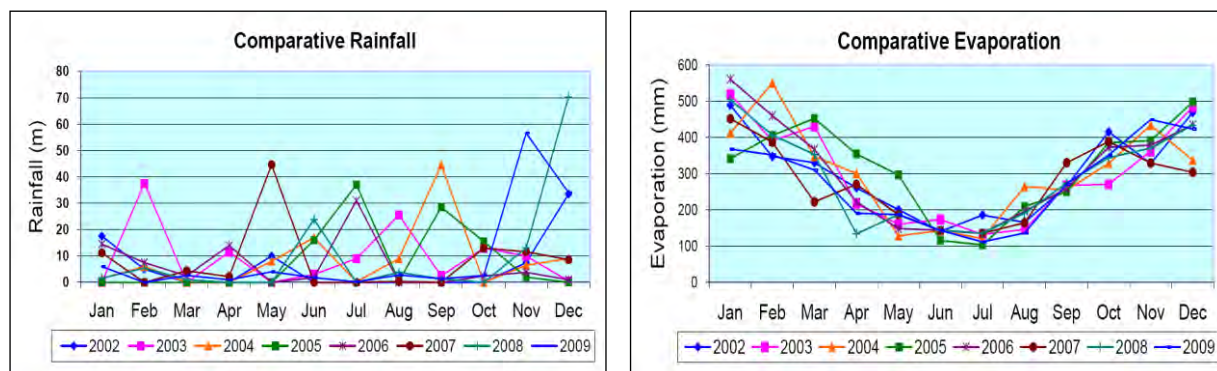


Figure 3-2: Comparative Annual Rainfall and Evaporation 2002 to 2009

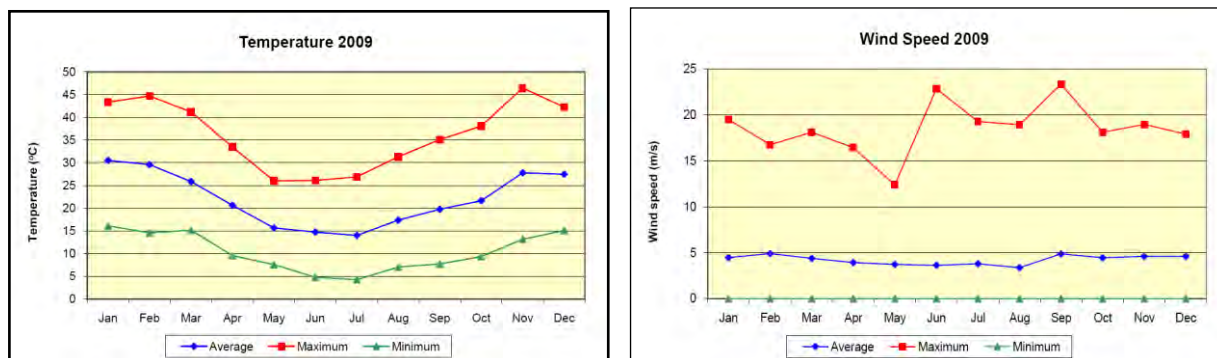


Figure 3-3: Monthly Average, Maximum and Minimum Temperature and Wind Speed

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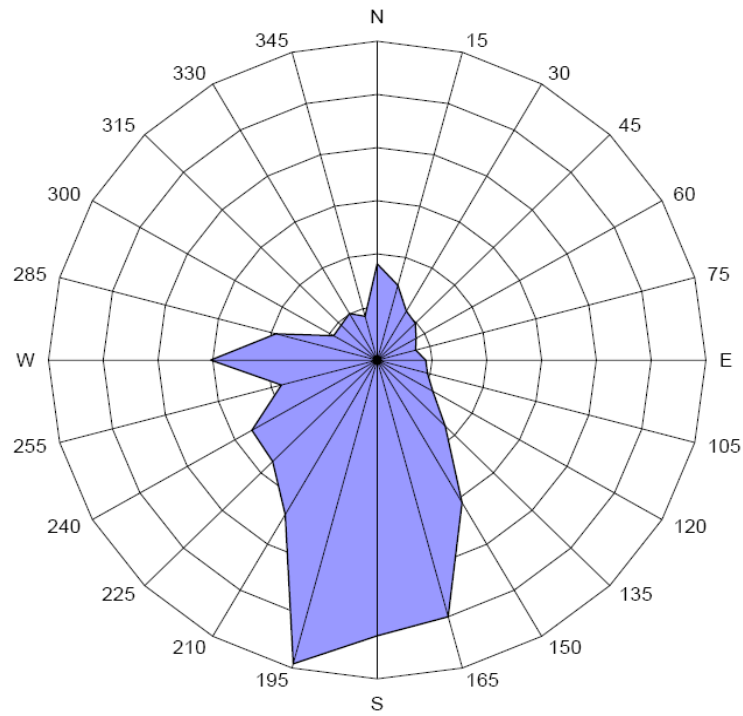


Figure 3-4: Wind Rose 2009



Plate 3-2: A mid afternoon dust storm at Beverley in September 2009

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3.2 Soil

The nature of mining at Beverley requires some soil disturbance. Topsoil is removed and stockpiled in areas where excavation, grading and calcrete or concrete capping is required. Examples are mud pits for drilling purposes, wellfield perimeter tracks and bunds, offices and sheds.

During 2008, Heathgate commissioned a soil study to provide additional background data for the Beverley mine that would in turn provide input into rehabilitation planning. This study provided more detail than was documented in the original Beverley EIS, and was included as Appendix E in the 2008 MARCR.

The findings of the study suggest it will be worthwhile returning old topsoil stockpiles to future rehabilitated areas if the saline and sodic subsoils would otherwise be left exposed at the surface, regardless of the biological status of the seed bank. Seed viability and biological activity of topsoil stockpiles may decrease with time.

Regulatory monitoring requirements together with the status of compliance are outlined in Table 3-1.

Table 3-1: Environmental Monitoring Requirements and Compliance Status - Soil

Location	Method	Parameter	Frequency	Compliance Status
Double lined Ponds (PLP and Evaporation Pond)	Seepage collected and measured over a known time period	Leakage converted to mL/m ² /d	Fortnightly	Compliant – no seepage occurred during 2009
PLP, Evaporation and Process Ponds	Electronic (PLP & Evaporation) Manual (Process Ponds)	Water Level	Weekly	Compliant
Site-wide	Manual area and affected depth or thickness measurements of spills of hazardous substances	Spill dimensions, diesel concentration (if not all removed)	When required	Compliant
Site-wide (Figure 3-7)	Surface sediment grab up and downstream of local creeks	Chemical parameters including radionuclides	Following rainfall events of >10 year ARI or at least once per year	Partially Compliant – the existing sites (S1-S10) were sampled in July - new sites (S11-18) were sampled in February 2010.

A potential problem is contamination of soil and watercourse sediments that might compromise its return to pastoral use arising from seepage from water management ponds, pond overflows or escape of mining solution due to accidental breakages of piping. Soils affected by spills are monitored for chemical and radiological contamination (the two are intrinsically linked).

The original evaporation ponds at the processing plant, Ponds 1 to 4, are checked manually for liner leaks on a daily basis. This is performed by inserting a cloth on the end of a pole (that runs from the top of the pond to beneath the liner) to soak up any moisture. Evaporation Pond 5 and the Pregnant Liquor Pond (PLP; pond 6) are monitored for leaks using an EC probe fitted between the double lining which transmits to an alarm in the Control Room if moisture is detected. No leaks were detected during 2009 and therefore no volumes have been recorded.

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Pond levels are recorded daily at midnight - Ponds 1-4 are recorded manually whilst Pond 5 and the PLP are measured via ultrasonic level indicators which automatically transmit to the Control Room. Evaporation pond 5 and PLP level results are displayed in Figure 3-5.

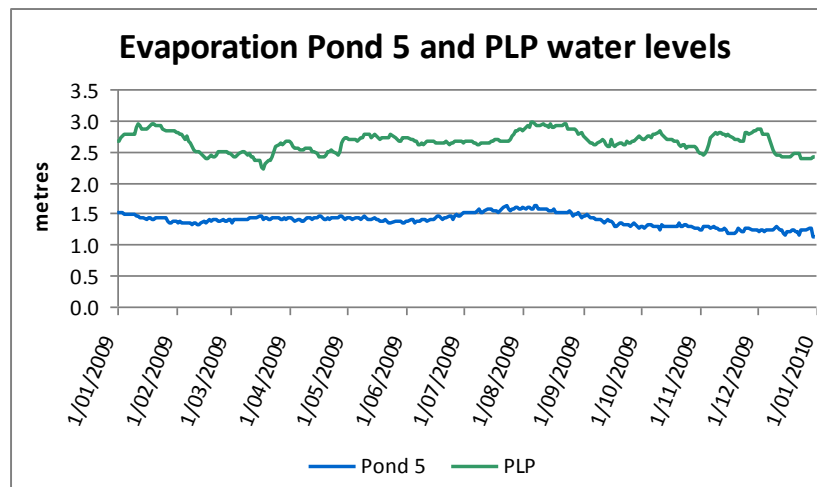


Figure 3-5: Evaporation Pond 5 and PLP water levels

No reportable spills occurred during 2009. Any spill results in the generation of an incident report and investigation and is logged in Heathgate's incident database.

Soils affected by hydrocarbon spills are collected and placed in lined windrows near the waste facility for bioremediation and later reuse as fill. Once a former and now obsolete diesel tank and stand have been removed, clean up from a historic spill will occur and this soil will then be collected and transported to lined windrows for bioremediation.

Sediment sampling is undertaken in order to assess the potential transport of contaminant, contained within sediments, from disturbed areas into local creek systems. Samples were collected from each transect across the creek using a small trowel. The top 5-10cm only is collected. Each sample is sieved to retain only particles $\leq 2\text{mm}$. These samples are analysed by a third party laboratory and the results of this analysis are presented in Figure 3-6 with sediment sampling sites shown in Figure 3-7.

Annual sediment sampling was conducted upstream and downstream in local creeks during July at existing sediment sampling sites S1 to S10. New sites S11 to S18 which were earmarked to be sampled for the first time in 2009 were inadvertently not included in the July sampling regime. These sites were however, sampled and sent for analysis in January 2010. There were also no 1-in-10 year ARI events during 2009 with monthly rainfall presented in Figure 3-1.

Comparison of the up and down stream concentrations for the mine site with that of the control sites show only traces of mine-related material have been detected immediately downstream of the mine (nothing for pH), with no concentrations of environmental or health concern. The creeks monitored at Beverley arise on the surrounding plains and are naturally low in radionuclides. Neighbouring creeks that accept sediment from the Flinders Ranges are typically 2-10 times higher in radionuclide concentration than the plains and higher than the downstream measurements shown in the graphs. Higher than average sulphate results have been recorded for upstream sediments in a number of years, 2004, 2007 and 2009. These results were recorded at only one of the upstream sites are unexplainable, as this site is west of the plant and wellfields and no activity, of any kind, occurs in its vicinity or upstream of the site. Results also show that this site has tended to return to background levels in subsequent years. Thorium (not shown) is also analysed and shows no discernable trends.

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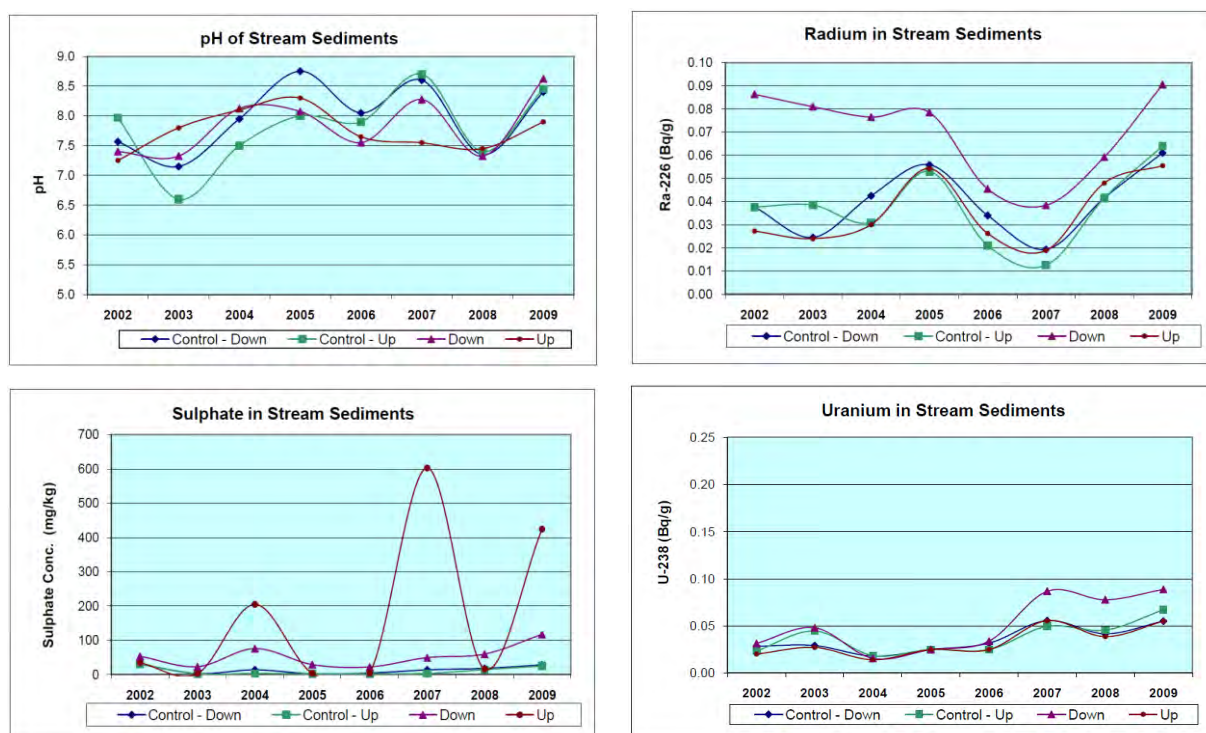


Figure 3-6: Chemical parameters for upstream and downstream sediment samples

Not all non-compliant off road incidents were recorded as an 'incident', although fencing was installed to prevent further access where required. Compulsory workshops were held during the year to educate all employees on the importance of remaining on existing tracks as well as other subjects relating to the minimisation of disturbance to the environment, including the necessity to obtain an Environmental Clearance Permit prior to undertaking works in undisturbed areas. The Environmental Clearance Permit allows for the establishment of a road network to prevent non-compliant off road incidents.

Also related to soil monitoring is the Ecosystem Function Analysis (EFA) monitoring program that occurs at Beverley. This also includes vegetation measurements and is described in Section 3.3.

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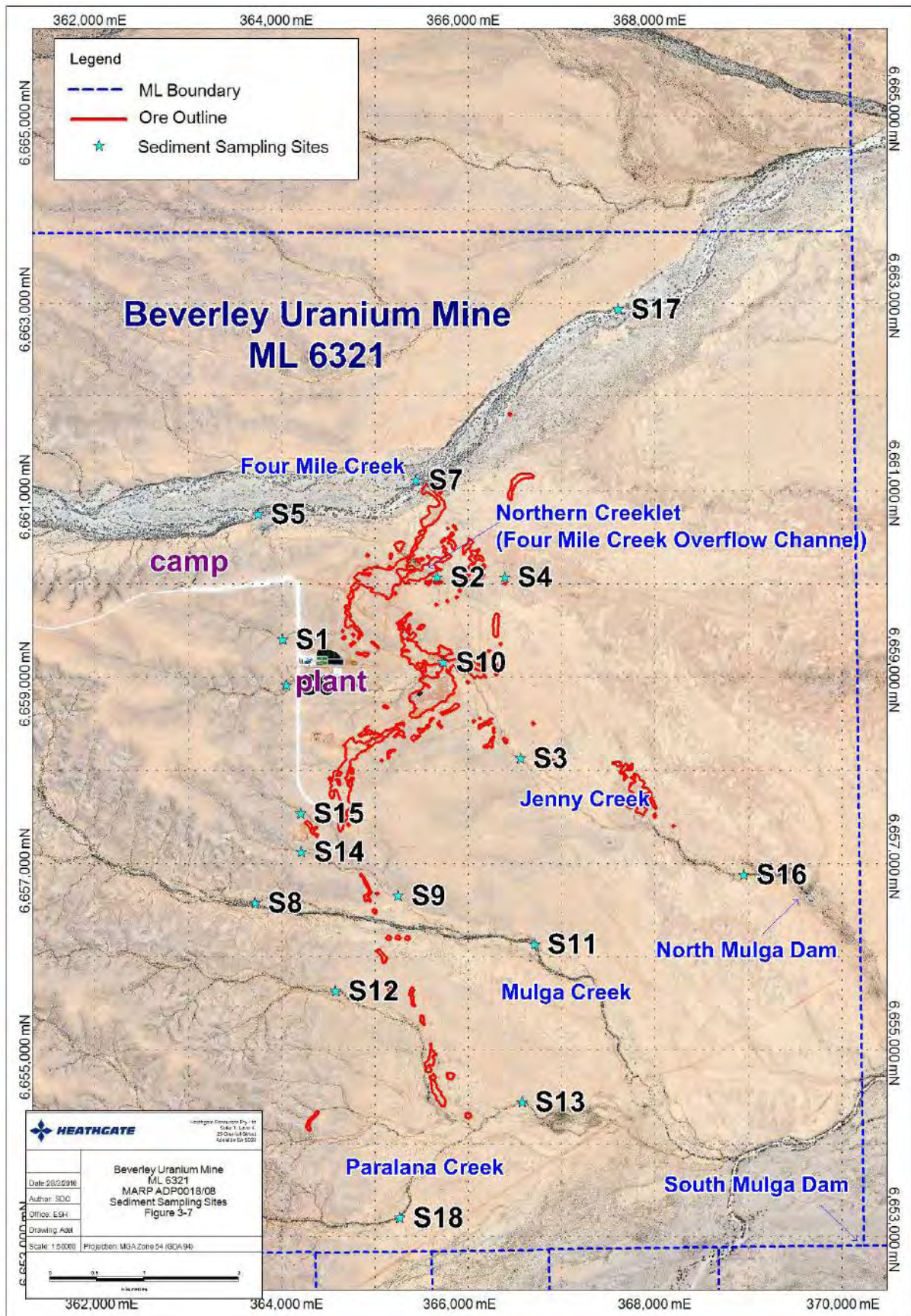


Figure 3-7: Sediment sampling sites

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3.3 Vegetation

Minimal disturbance and removal of vegetation occurs at Beverley due to the nature of mining with no species or vegetation associations being threatened by the operations as these associations are widespread in the surrounding area.

Even though disturbance and vegetation is very small relative to other mining techniques, rehabilitation via establishment and growth of native vegetation after clearing is slow hence the management strategies in place assist in minimising disturbance.

Regulatory monitoring requirements and the status of compliance are outlined in Table 3-2 with monitoring sites shown in Figure 3-8.

Table 3-2: Environmental Monitoring Requirements and Compliance Status - Vegetation

Location	Method	Parameter	Frequency	Compliance Status
ML and Local Area	Survey 5 m x 2 m vegetation quadrats	Species richness and total cover for all plant species and perennials only	Annually	Compliant
	Survey 4 x 1 ha quadrats for weed abundance	Weed species and cover	Annually	Compliant - 4 x 1 ha quadrat now in place and surveyed.
ML	Opportunistic watch –look for and record any alien species.	Number of species and their density	Following rainfall and during Annual Survey	Compliant
	Aerial photograph – comparisons with previous photographs to assess site wide vegetation cover changes	Vegetation cover	Biannually (odd-numbered years)	Compliant - aerial photograph captured 20 March 2009
	Prior to any planned disturbance issue Environmental Clearance Permit and document expected disturbance. Measure actual disturbance at completion of year by GPS.	Percent Actual vs Expected Disturbance Area	Annual (December)	Compliant - actual disturbance measured by GPS for the purpose of SEB accounting in March 2010
	Map extent of any fire should one occur	Area burned and distance from boundary	If required	Compliant – no fires occurred during 2009

The report titled “Beverley Uranium Mine Vegetation Monitoring Observations September 2009” (Appendix B) states that in all land use areas and in all landforms:

- Mitchell Grass grasslands, once dominant in the area, continue to be in very poor condition or absent
- Most other perennial species have declined in cover
- Fewer species were recorded than in previous surveys
- No threatened species were identified.
- Total species richness and cover were low in all areas in 2009 than in 2008.

At the time of the vegetation survey the once dominant Mitchell Grass was at its lowest recorded level. Grazing pressure from kangaroos on the ML and from cattle and kangaroos on pastoral country continued to be more or less equal, although there was less grazing impact from cattle during the past year than in previous years. Cattle numbers on Wooltana Station were the lowest on record since the start of mining operations. The total grazing pressure is of greater importance than grazing by domestic stock or any single herbivore.

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Other than grazing and effects associated with seasonal conditions, there are no off-target impacts evident from photopoints for the period September 2008 to September 2009.

Three more 1 ha quadrats were set up in the ML extension area as requested by the regulators for the purpose of monitoring weed abundance however Badman points out that this provided no information that was not already provided by the 5 m x 2 m quadrats at these sites.

The most commonly found weed species in previous years, *Solanum nigrum* (Black Nightshade) was not recorded in the official survey in 2009 after an intensive control campaign carried out by environmental staff and the control of some water outflows. Some Black Nightshade and Rosy Dock (*Acetosa vesicaria*) was removed by environmental staff from around the processing plant during the year. A single alien plant *Nicotinia glauca* (Tree Tobacco) was recorded in the plant car park during 2009 and this plant was removed. One other individual of this species was recorded in 2007 at pond area within the processing plant fenced area and its immediate removal has thus far resulted in no recurrence.

An aerial photograph was captured on 20 March 2009 to comply with the odd year biannual frequency. Photomonitoring was undertaken at all sites on a quarterly basis and showed no evidence of erosion for the period. In addition to this, Badman (2010) recognises no additional erosion was evident during the annual vegetation survey.

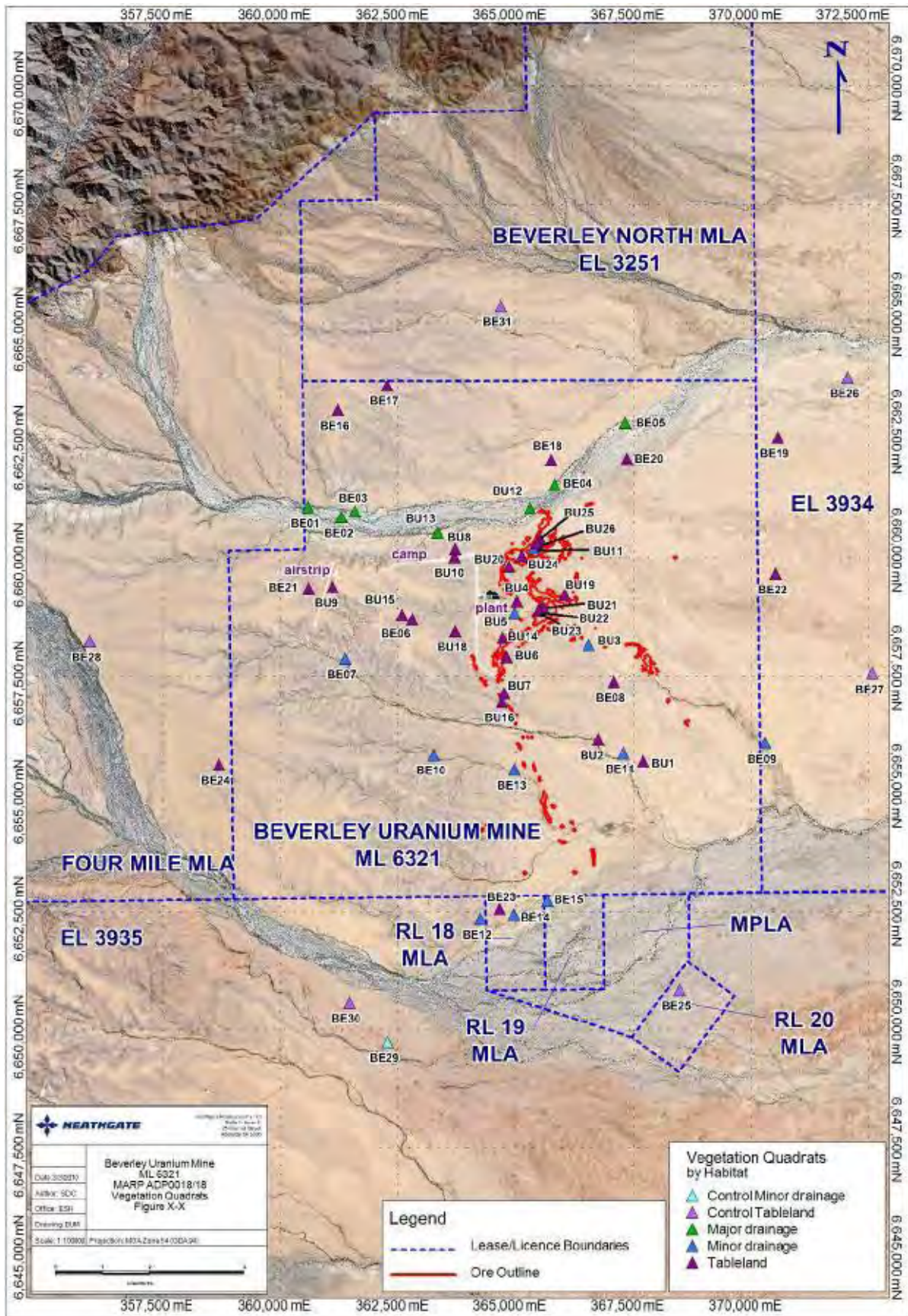
All clearing was undertaken in accordance with the MARP and in accordance with Heathgate's Environmental Policy and Standard Operating Procedure for Environmental Clearance Permits (ECPs). ECPs must be obtained prior to any disturbance occurring in any area within the Mining Lease. There were no fires that affected the vegetation or ecosystem within the ML boundary during 2009. Badman (2010) states:

“no evidence was seen of any fire occurring on the mine lease or in surrounding pastoral country. In fact it would have been very difficult to find enough vegetation to sustain a fire in these areas.”

SEB (Significant Environmental Benefit) compensation is required for land cleared under authorisations given since 25 August 2003. The majority of the clearing at the site to date was approved under the initial EIS and MARP approvals for the Beverley Project and is therefore not subject to SEB even when physically cleared after 25 August 2003.

The following section discusses the EFA monitoring as a tool, determinations reached thus far and recommendations by consultants. Progressive accounting for SEB is detailed separately in Section 5.

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3.3.1 Ecosystem Function Analysis

Ecosystem Function Analysis (EFA) is supplementary monitoring committed to in the 2008 MARP rather than compliance monitoring. The status for this monitoring is set out in Table 3-3. EFA monitoring is primarily a tool for assessing rehabilitation. Background monitoring to establish local norms and trends has commenced. EFA is being used to assess progress with the (currently) relatively small areas of rehabilitation.

EFA assessment will contribute to improving rehabilitation techniques when larger areas become available for rehabilitation over the next few years, and investigations into its use as part of the closure criteria for the Beverley Mine will continue in 2010.

It has been determined and confirmed through EFA assessments that scarifying the surface to form shallow banks and troughs, promotes better rehabilitation than allowing the natural elements (mainly wind) to contour the surface with crabholes.

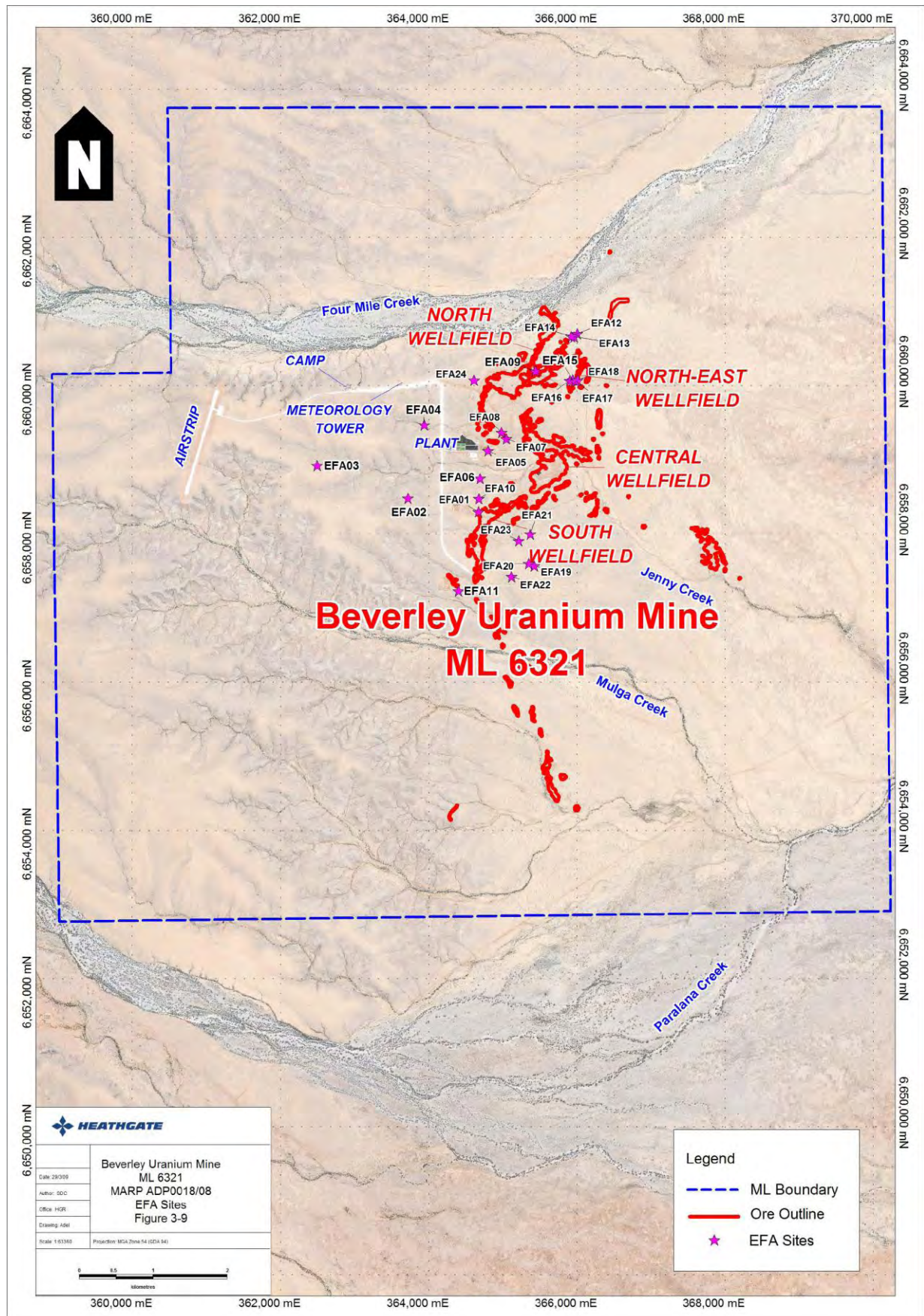
Table 3-3: Environmental Monitoring Requirements and Compliance Status - EFA

Location	Method	Parameter	Frequency	Compliance Status
Ecosystem Function Analysis (EFA) transects at both analogue (control) and disturbed areas Lease and Local Area	Determination of: geographic setting of site; landscape organisation and soil surface assessment (rain splash protection, perennial vegetation cover, litter, cryptogram cover, crust brokenness, soil erosion, deposited materials, surface roughness, surface nature, slake test, texture)	Soil stability, water infiltration and nutrient recycling	Annually	Compliant
	Point centred quarter – sampling points established on EFA transect at regular intervals – at each point distance to nearest perennial plant in each of four sectors measured.	Plant cover, density and diversity.	Annually	Compliant
	Wandering Quarter – in areas with plants over 3 m in height - measuring 25 plants over 3 m in height within a 90 ° arc starting at the 0 m post of EFA transect.	Upper-storey cover and density in areas with plants over 3 m in height.	Annually	Compliant – consultants suggest monitoring to include individuals over 2m in height (refer text below).

Outback Ecology undertook baseline monitoring for EFA in November 2006 and annual surveys have followed since - November 2007, October 2008 and November 2009. The EFA surveys include a vegetation component that compliments the specialised vegetation monitoring currently undertaken by Badman Environmental. Figure 3-9 shows the location of EFA monitoring sites and the 2009 EFA report is given in Appendix C.

EFA09, located within a minor drainage channel, being the only EFA transect on ML 6321 to possess an upper storey which meets the Wandering Quarter criteria is comprised almost solely of *Acacia tetragonophylla*. During the 2009 survey, it was found that, as only trees over 3 metres in height were sampled more than 350 m was traversed in order to get a statistically valid sample of 25 individuals. This resulted in a data set representing an area much greater than the immediately adjacent 50 m transect. In 2007 and 2008, the overstorey was not considered significant enough to warrant independent assessment using the Wandering Quarter method. The EFA consultants have suggested reducing the monitoring height to over 2 m to give a higher number of samples within the actual transect area thus providing a more statistically valid sample.

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3.4 Surface Water

Surface water assists in the recharge of the surficial aquifer, the Willawortina Formation. When surface water is present on the ground surface it is used by native fauna and stock. Surface water dams are used by pastoralists as (often intermittent) stock water supplies.

The nature of mining at Beverley requires very little disturbance to the hydrology of the area, as there are no creek diversions or significant catchment area reductions or alterations required. Regulatory monitoring requirements together with the status of compliance are outlined in Table 3-4.

Table 3-4: Environmental Monitoring Requirements and Compliance Status – Surface Water

Location	Method	Parameter	Frequency	Compliance Status
North and South Mulga Dams	Surface water grab sample (mass balance calculation to be undertaken after analysis)	pH, EC, SO ₄ , U	As soon it is possible to safely drive a vehicle to the sites after a mining or disposal solution spill if creeks were flowing at the time	Compliant. No samples were taken for the specific purpose of meeting compliance as there were no spills when creeks were flowing

Creeks of various sizes and flow potential are crossed by roads, tracks and pipelines. Design measures are in place and engineered creek crossings aid in the protection of creeks and their associated ecology.



Plate 3-3: Engineered creek crossings

The processing plant, ponds and wellhouses are situated in areas above the 1-in-100 year ARI flood level. Flood level maps are used in the design of pipe routes and flood protection. Production well installation is minimised in flood prone areas. Daily plant and wellfield checks incorporate visual assessment of infrastructure. A 'no reversing in wellfields' rule applies to prevent damage to wellfield infrastructure and signage is posted at entries to wellfields.

Sufficient freeboard in ponds ensures a high rainfall event will not result in overtopping. Pond levels are monitored daily. Refer to Soils (Section 3.2) as parallels to soil protection apply.

There was no regulatory requirement to take a grab sample of the surface water from the North and South Mulga Dams as there were no mining or disposal solution spills while creeks were flowing. Grab samples were taken however following rainfall in December when local creeks flowed and the results from this sampling will be added to existing background data.

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Plate 3-4: Minor creek flow in November 2009

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3.5 Hydrogeology

The hydrogeology in the vicinity of the Beverley Mine consists of three main aquifers:

- Willawortina Formation (surface to ~95 m below ground level (bgl))
- Beverley Sands and other minor sands in the Namba Formation (105 – 140 m bgl)
- Great Artesian Basin (GAB) – Cadna-Owie Formation (330 – 380 m bgl).

3.5.1 Great Artesian Basin (GAB)

Monitoring of the GAB water from the three GAB bores on the ML provides an early warning of possible problems that might occur at pastoral wells in the area and provides assurance that the outcome of 'no compromise to other existing GAB users within the Beverley Mine region' will be achieved.

The regulatory monitoring requirements and the status of compliance are outlined in Table 3-5 below.

Table 3-5: Environmental Monitoring Requirements and Compliance Status – Hydrogeology GAB

Location	Method	Parameter	Frequency	Compliance Status
Plant GAB Bores (2) and Four Mile GAB Bore	Draw down – Analysis of pressure data for any trending artesian pressure drops.	Pressure	Continual logged data	No prolonged decrease in pressure drop of the GAB bores
	Flow rate totaliser – Continuous flow meter with data logger.	Volume	Continual when flowing	A draft licence has been issued by DWLBC and a variation sought by Heathgate which was under consideration during the reporting period – in Mar 2010 Heathgate was advised an allocation of 140 ML/yr had been approved
	Water sample – Grab sample from GAB bores.	EC	Quarterly	Compliant

GAB pressure has remained constant at Four Mile GAB and Plant GAB 2 which indicates a constant rate of sustainable water use from these wells. The observed approximate 30 kPa pressure increase at Plant GAB 1 from 2006 onwards is likely to be due to a reduction in the rate of use from this well following the commissioning of Plant GAB 2. During the period of monitoring since 2005, there is no ongoing decline (drawdown) of aquifer pressure. The pressure in each bore follows a similar monthly variability.

Pressure readings are taken at the three GAB bores each month by one of the environmental personnel. Results obtained from monthly pressure monitoring are shown in Figure 3-10. Lower pressures in Plant GAB 1 and to a lesser extent Four Mile GAB tend to be lowest in summer when water demand is higher, with full recovery each winter.

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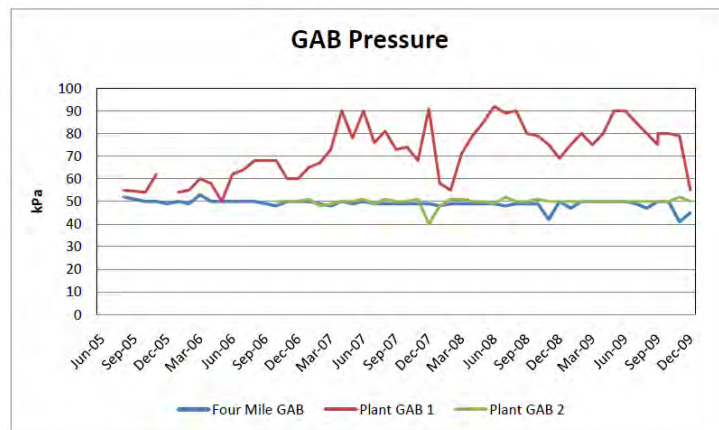


Figure 3-10: GAB pressure and conductivity of GAB bores

Volume and pressure readings for both Plant GAB bores are taken at midnight of each day and a volume reading is taken at the Four Mile GAB each Saturday. Volumes extracted quarterly from each of the three GAB bores are shown in Figure 3-11.

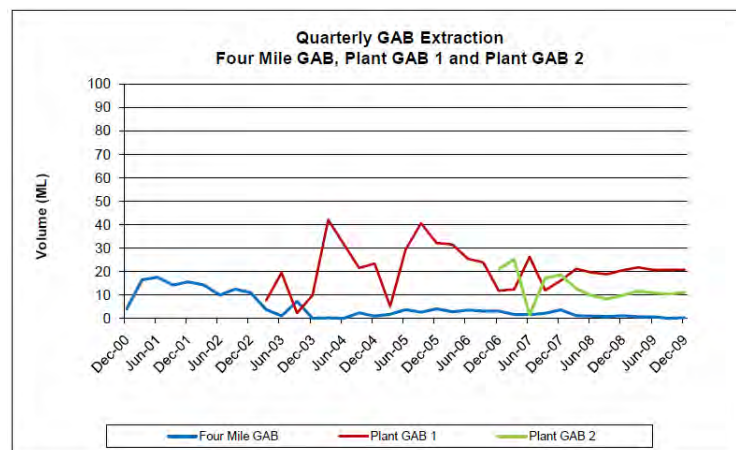


Figure 3-11: Quarterly extraction from the three GAB bores

Figure 3-13 shows the total GAB extraction of all bores on a quarterly basis and the annual total GAB extraction for the years 2000 to 2009 is shown in Figure 3-13.

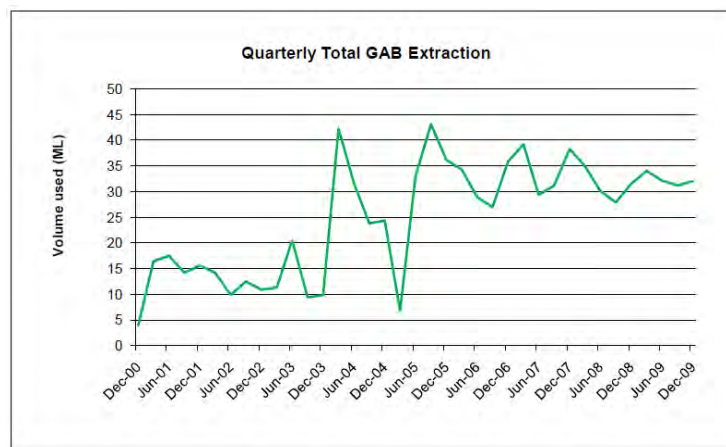


Figure 3-12: Quarterly total GAB extraction

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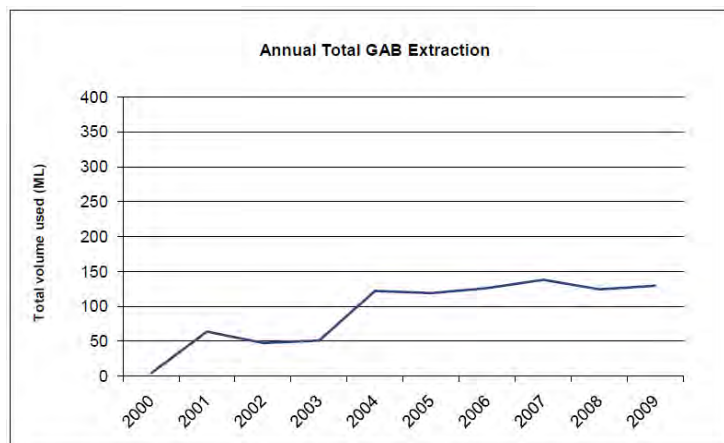


Figure 3-13: Annual total GAB extraction

The results of EC monitoring for the three GAB bores over the last several years is shown in Figure 3-14.

Salinity, as indicated by Electrical Conductivity (EC), is within historic variation for Plant GAB 2, and most recently slightly above the historic range for Plant GAB 1. The last few measurements from the Old Camp GAB Bore (also referred to as Four Mile GAB Bore) were about 200 uS/cm (5%) above the previous 3 years of data.

Overall there appears to be a small sustained increase in salinity from the wells under sustained use. No specific interpretation is placed on the apparent trends from the bores, all of which are allowed to flow naturally such that the hydraulic gradients from the GAB towards other aquifers are maintained. Ongoing monitoring will show if the trends are significant or not.

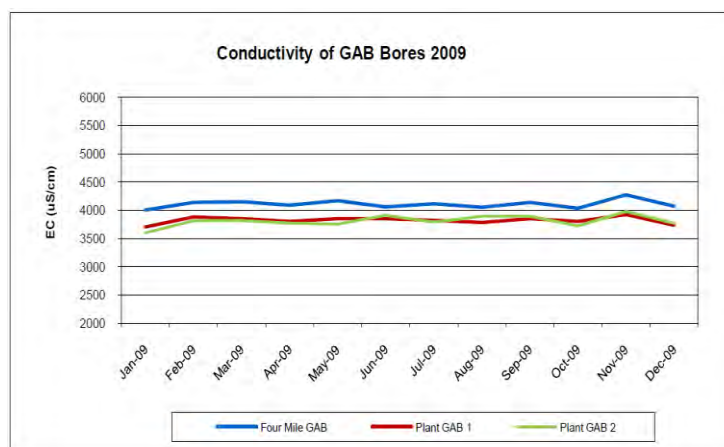


Figure 3-14: Conductivity of the GAB bores

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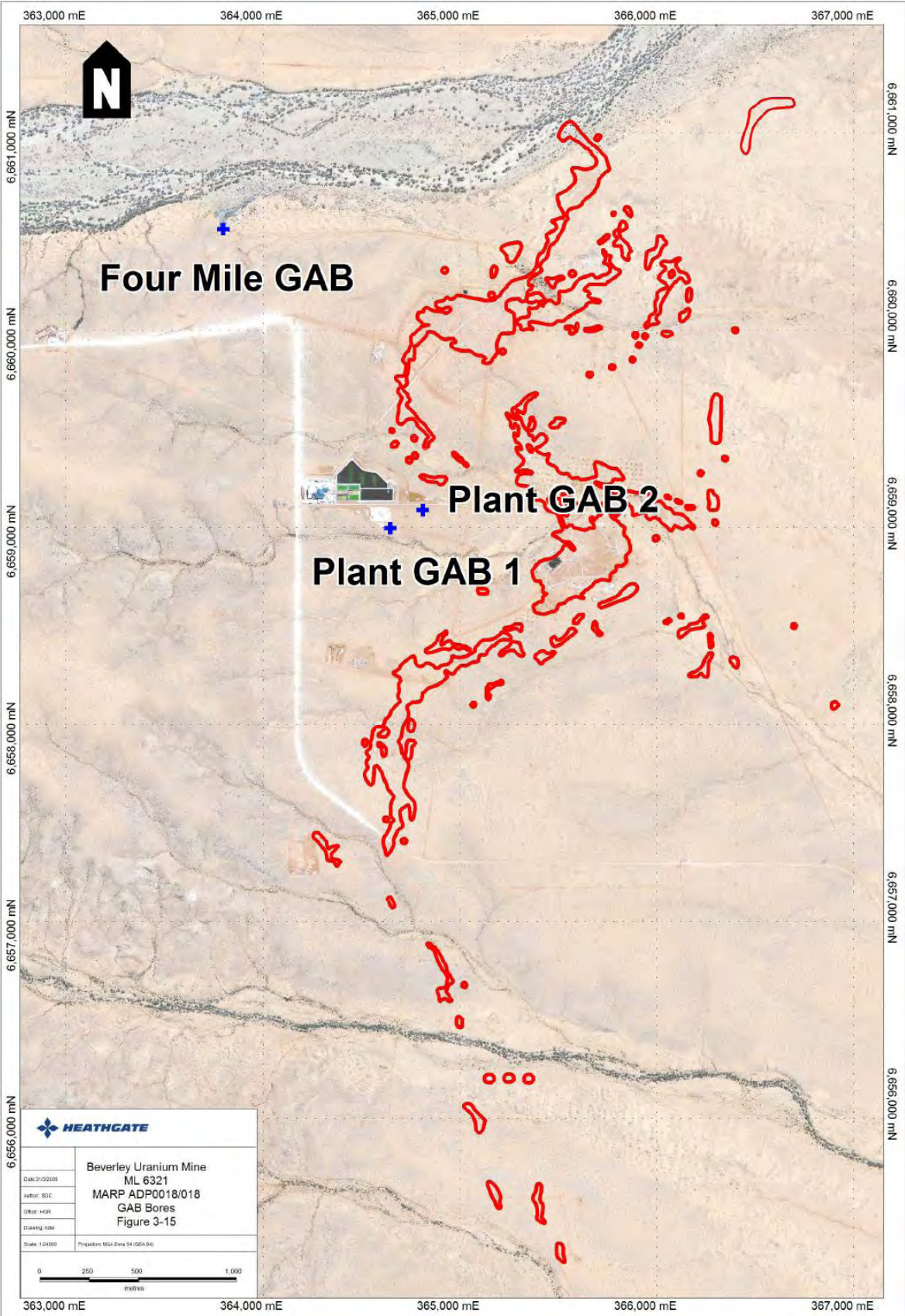


Figure 3-15: GAB Bore locations

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3.5.2 Namba Formation

Mining occurs in the uranium-bearing Namba Formation aquifer. Due to its saline and naturally radioactive nature it is accepted by the regulators that there are no environmental values for and no potential beneficial use of this aquifer at the Beverley mine other than mining.

Pumping tests show the limited extent and variability of the Namba Formation 'bath tub' aquifers and are used in the design of wellfields.

The Namba formation is monitored via a network of monitor wells and the frequency and type of monitoring undertaken is determined according to the classification of a well as shown in Table 3-6 below. All regulatory wells that are classified within Type 1 to 3 are fitted with low flow bladder pumps to obtain samples for chemical monitoring.

Table 3-6: Namba Formation Monitor Well classification

Type		Hydraulic connection to mining zone	Spacing	Distance from mined zone	Water level monitoring	Chemical monitoring pH, SO ₄ , U
1	Channel monitor wells (across the Paleochannel aquifer)	Well connected	100 m	250 m	fortnightly	fortnightly
2	Lateral - Along Paleochannel (well connected)	Well connected	250 m	250 m	fortnightly	fortnightly
3	Lateral - Along Paleochannel (poorly connected)	Poorly connected	350 m	350 m	quarterly	quarterly
4	Lateral Along Paleochannel (un-connected)	Very poorly connected	750 m	350 m	quarterly	nil

Excursion Control Limits (ECLs) exist for pH, sulphate and uranium in the Namba Formation regulatory monitor wells (Table 3-7). Duplicate sampling of regulatory monitor wells is undertaken on a quarterly basis and duplicates are sent off site to a NATA accredited laboratory. Results from Beverley's laboratory and the NATA accredited laboratory are compared for quality assurance purposes.

All level data for the regulatory Namba Formation monitor wells were presented to the regulators on a quarterly basis. All chemistry data for the Namba formation was reported to the regulators on a quarterly basis during 2009. No excursions from the mining zone have occurred since operations began. Results of monitoring are shown in graphical form in Appendix D.

The 2008 MARP outlines Heathgate's contingency plan should an excursion ever occur and persist.

Table 3-7: Environmental Monitoring Requirements and Compliance Status – Hydrogeology – Namba Formation

Location	Method	Parameter	Frequency	Compliance Status
Namba Formation	Manual dipping or water level logger for water level	760 kPa/7.6 m artesian at wellhead	Types 1 & 2 – Fortnightly Types 3 & 4 - Quarterly	Compliant
	Pumped sampling and laboratory testing for pH, SO ₄ , U	ECLs: pH: 4.5, SO ₄ : 3.6 g/L, and U: 1 mg/L	Types 1 & 2 – Fortnightly Type 3 - Quarterly	Compliant

During 2009, three Namba monitor wells were removed from the regulatory monitor well network and fifteen to ensure that monitoring occurs where required as mining moves out of and in to different areas. A monitor well status report is provided to the regulators on a

quarterly basis and the location of all wells can be seen in

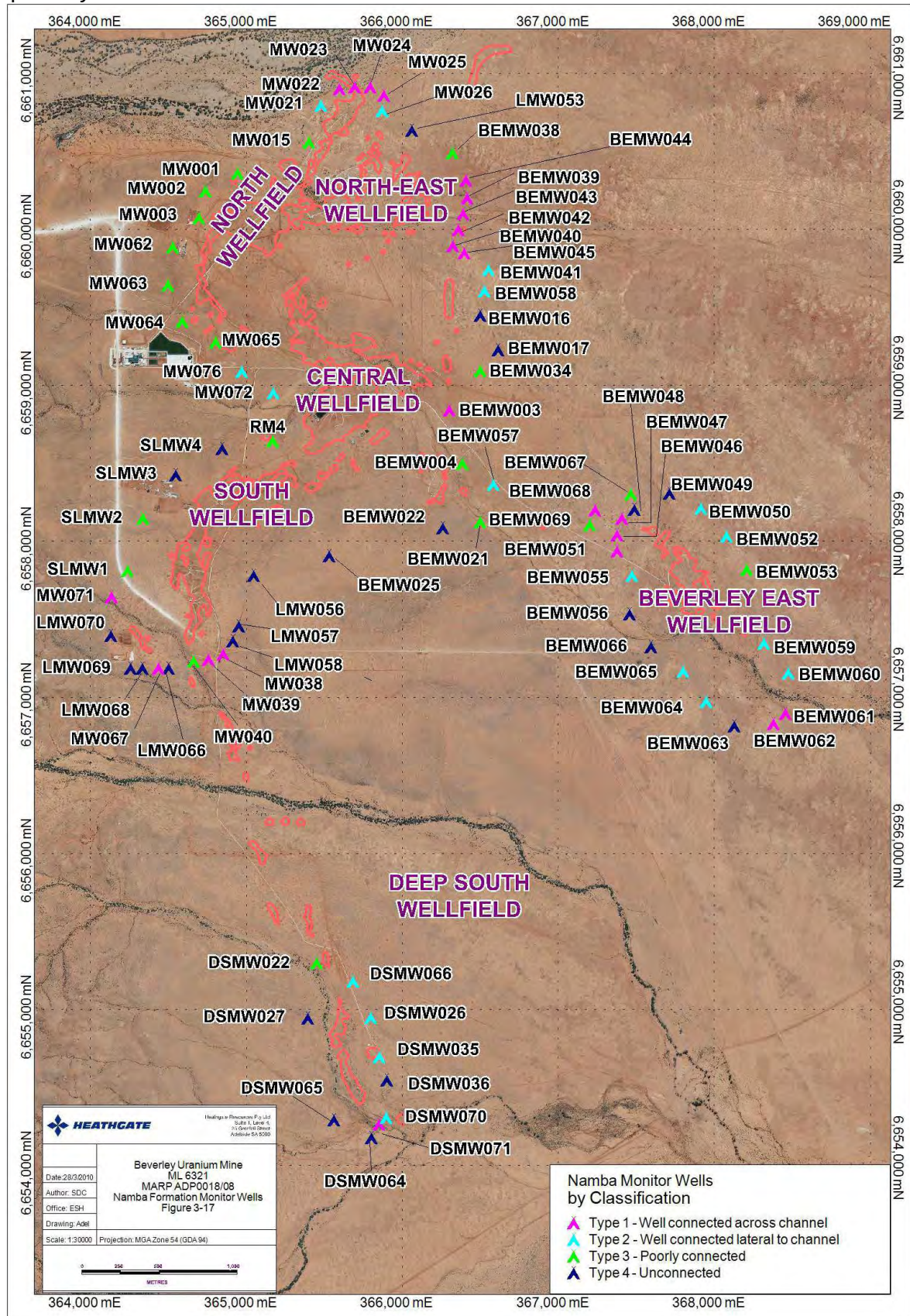


Figure 3-16.

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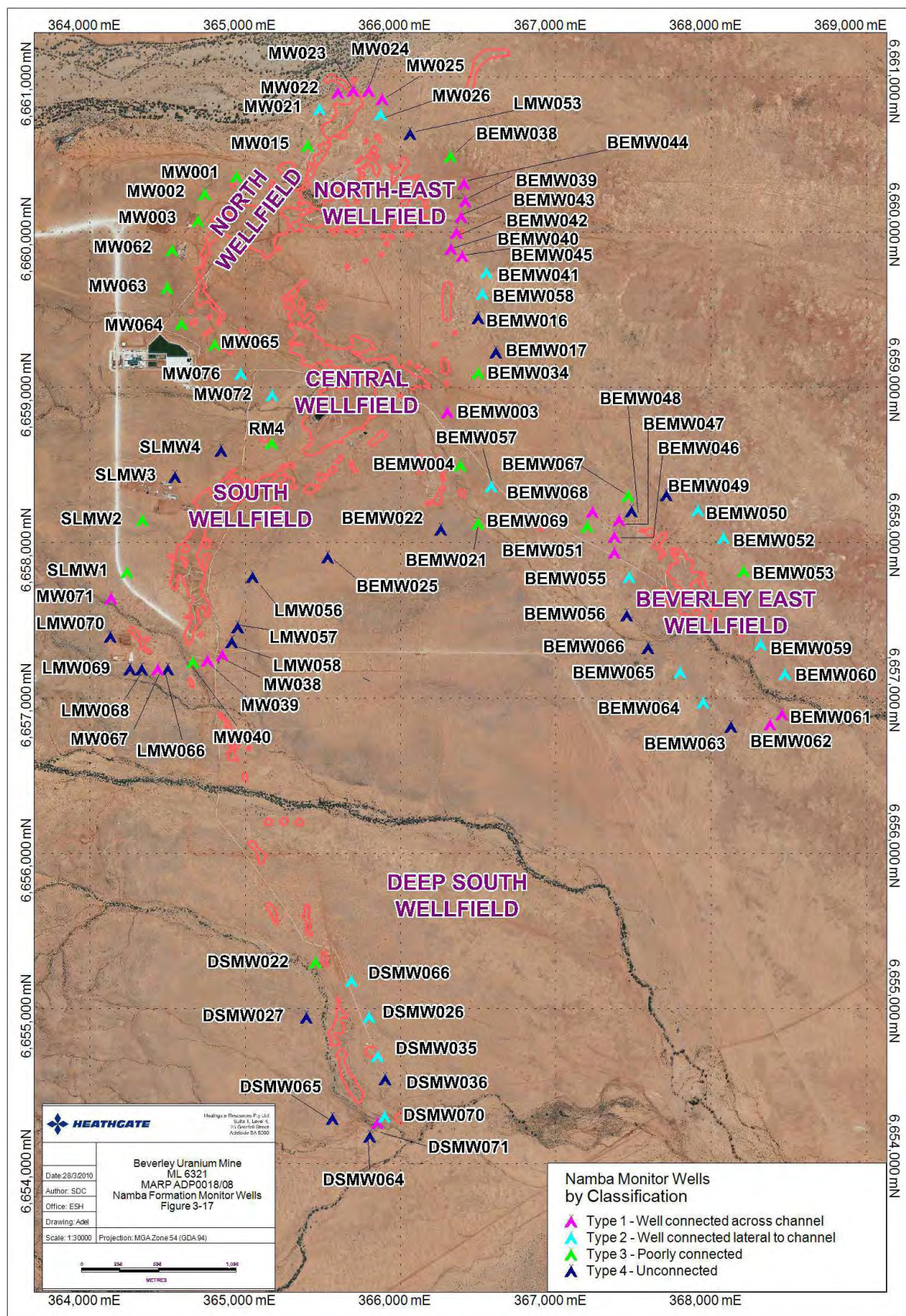


Figure 3-16: Namba Formation monitor well locations

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3.5.3 Willawortina Formation

The Willawortina Formation overlies the Namba Formation and is separated by an impervious clay layer. The Willawortina Formation comprises a number of thin aquifers of low water yield, separated by clay layers. Where water is present, the quality may be suitable for general stock use. Pumping tests associated with trials indicate there is no hydraulic connection with the Namba Formation aquifer.

Supervision during construction of the low level radioactive (LLR) waste facilities occurs including verification of the size/area, slope, sump drainage, fall and depth. GPS coordinates of the four corners of each LLR waste facility are recorded and photos of prepared facilities prior to use/filling are taken which show the sump and lining. Reports are generated by the radiation section and sent to the EPA-RPD when LLR waste facilities are fully completed and capped.

Monitor wells screened in the Willawortina Formation are known as overlying monitor wells and are spaced so that no production well is more than 250 m from any overlying monitor well. One overlying monitor well was added to the regulatory monitor well network to provide cover for a new wellfield in South Beverley before mining there began. The location of overlying monitor wells and the coverage they provide is shown in Figure 3-17. Overlying monitor wells are dipped fortnightly and sampled quarterly as outlined in Table 3-8.

Table 3-8: Environmental Monitoring Requirements and Compliance Status – Hydrogeology - Willawortina Formation

Location	Method	Parameter	Frequency	Compliance Status
Willawortina Formation	Manual dipping or water level probe	Water level	Fortnightly	Compliant
	Sampling and laboratory testing	ECL parameters and EC	Quarterly	Compliant

Duplicate sampling of overlying monitor wells is undertaken on a quarterly basis and duplicates are sent off site to a NATA accredited laboratory. Results from Beverley's laboratory and the NATA accredited laboratory are compared for quality assurance purposes.

Monitoring results are presented in the Quarterly Environment and Radiation Report presented to the regulators. No excursion into the Willawortina Formation has ever occurred. Results of monitoring are shown in graphical form in Appendix E.

To demonstrate the fulfilment of the second part of Recommendation 6 of CSIRO's "Review of environmental impacts of the acid in-situ leach mining process", Heathgate prepared the "Waste disposal pits monitor well network completion report which is given in Appendix F. In relation to this report, three overlying monitor wells are located immediately surrounding the LLR waste and do not appear to be connected to the main aquifer thus sampling via low flow bladder pumps has proven problematic. The use a bailer has proven successful for obtaining samples and results show no uranium concentrations above 1 ppm as do overlying monitor wells nearby the LLR facilities.

Dump sump bores which are monitored monthly are linked to the base of each waste facility and in general, show no signs of liquid. If a liquid sample is present, it is obtained and sent to a third party NATA accredited laboratory for analysis. To date only low Ra-226 concentrations have resulted. This is consistent with the assertion that radionuclide contamination of the Willawortina aquifer is not a credible risk.

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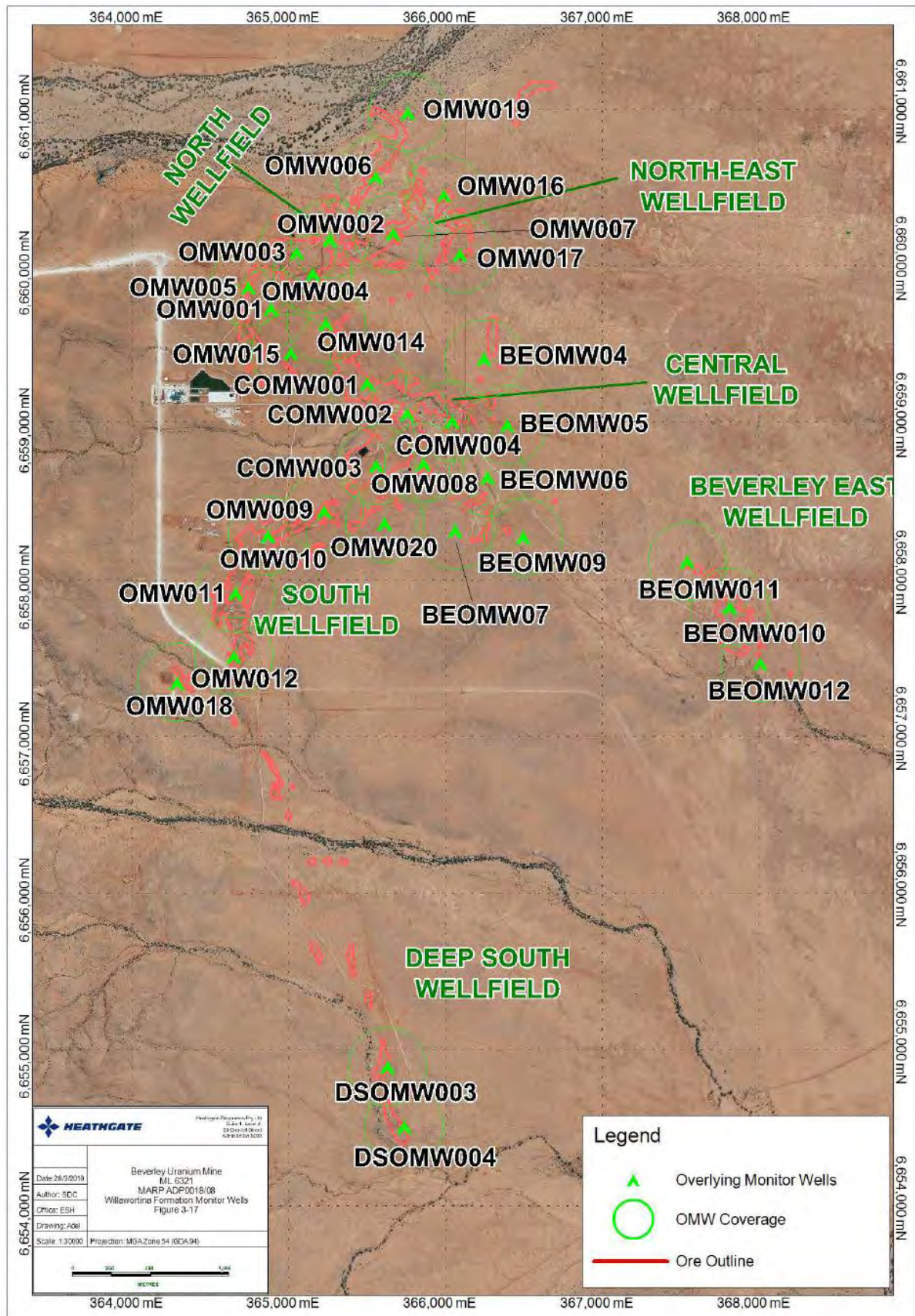


Figure 3-17: Willawortina Formation monitor well locations

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3.6 Fauna

The disturbance and removal of some vegetation and disturbance of other fauna habitat, as part of mining and exploration activities, does occur at Beverley. Prior to any new activities an Environmental Clearance Permit is required to ensure that all disturbances are kept to a minimum. All fauna species found on the Beverley lease are widespread and their respective habitat niches are numerous replicated. This helps ensure that the minimal disturbance poses no threat to any species, whose individuals may be affected by operations at Beverley. It is, however, considered important to minimise the impact on fauna, the aim of management strategies in place.

Any accidental deaths of fauna that occur as part of operations are recorded in both an animal register log book and on the environmental database.

Trapping and baiting is undertaken to keep the populations of feral animals in check, such as the house mouse (*Mus musculus*), the cat (*Felis catus*) and dingo (*Canis lupus dingo*).

The outcomes related to fauna are measured via the results obtained from the annual fauna survey that is undertaken by consultants, and by monthly bird and macropod transects, undertaken by Heathgate's environmental personnel as set out in Table 3-9.

The Annual Fauna survey was undertaken by Environmental Biodiversity Services (EBS) from 8 to 23 October 2009. Six original sites have been monitored in and around the original mining lease, ML 6036, since 1996. An additional four sites incorporated on the the lease extension, ML 6321, have been included in the annual monitoring since 2007. Six control sites were set up and monitored from 2008 with a further two control sites added in the 2009 survey. The control sites are located approximately 5 km away from areas of known mineralisation and mining activities.



Plate 3-5: Sleepy Lizard (*Trachydosaurus rugosus*), reptile found in the Beverley area

EBS attributes the year to year variance in diversity and abundance of fauna species to climatic conditions rather than loss of habitat due to mining. The preceding ten months to the 2009 fauna survey were the driest recorded at the site over the past ten years with less than 25mm of rainfall. There was no significant difference in abundance or diversity, of fauna species, recorded between the control and Beverley sites by EBS in 2009, although they did record a higher abundance of mammals at the Beverley sites. No new feral species were recorded and no inference of the abundance of feral animals within the lease area compared with adjoining pastoral areas was made.

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Table 3-9: Environmental Monitoring Requirements and Compliance Status - Fauna

Location	Method	Parameter	Frequency	Compliance Status
Lease and Local Area at established points. See Figure 6-6	Terrestrial mammal and reptile trapping program utilising a line of pitfall traps with nearby Elliot and cage traps. Fauna will be identified, sexed, marked and released unless otherwise required by trapping permit (e.g. voucher specimens for SA Museum). Undertaken at all sites.	Total number of species and abundance at each site	Annually – 6 day survey	Compliant
	Bird transect – walked traverse logging species and abundance. Undertaken at all sites.		Annually	Compliant
BU-12	Microchiropteran bat trapping - using harp trap each night.		Annually – 6 day survey	Compliant
North Mulga Dam	Anabat – record ultrasonic echolocation calls and send to specialist consultant for analysis.		3 evenings during annual 6 day fauna survey	Compliant
	Microchiropteran bat trapping – mist net set up on evenings when wind conditions allow.			Compliant
Process Ponds	Bird transect - walked traverse logging species and abundance.		Monthly	Compliant
	Anabat – Record data and send to specialist consultant for analysis.		3 evenings during annual 6 day fauna survey	Compliant
Four Mile GAB Bore wetland	Bird Transect - walked traverse logging species and abundance.		Monthly	Compliant
	Opportunistic sighting.		Annually	Compliant
Lease and Local Area	Spotlight traverse – night drive with spotlight randomly around site and local area roads recording number and species of animals.		Annually	Compliant
Wellfield	Bird Transect – walked traverse logging species and abundance.		Monthly	Compliant

Heathgate undertakes trapping and euthanasia of feral animals. House mice are most commonly caught, but each year a small number of rabbits and feral cats may be caught. As the owner of the Wooltana pastoral lease that is below the Dog Fence, Heathgate undertakes the required wild dog baiting on Wooltana Station that includes the Beverley Mine area.



Plate 3-6: Two wild kittens caught during routine trapping

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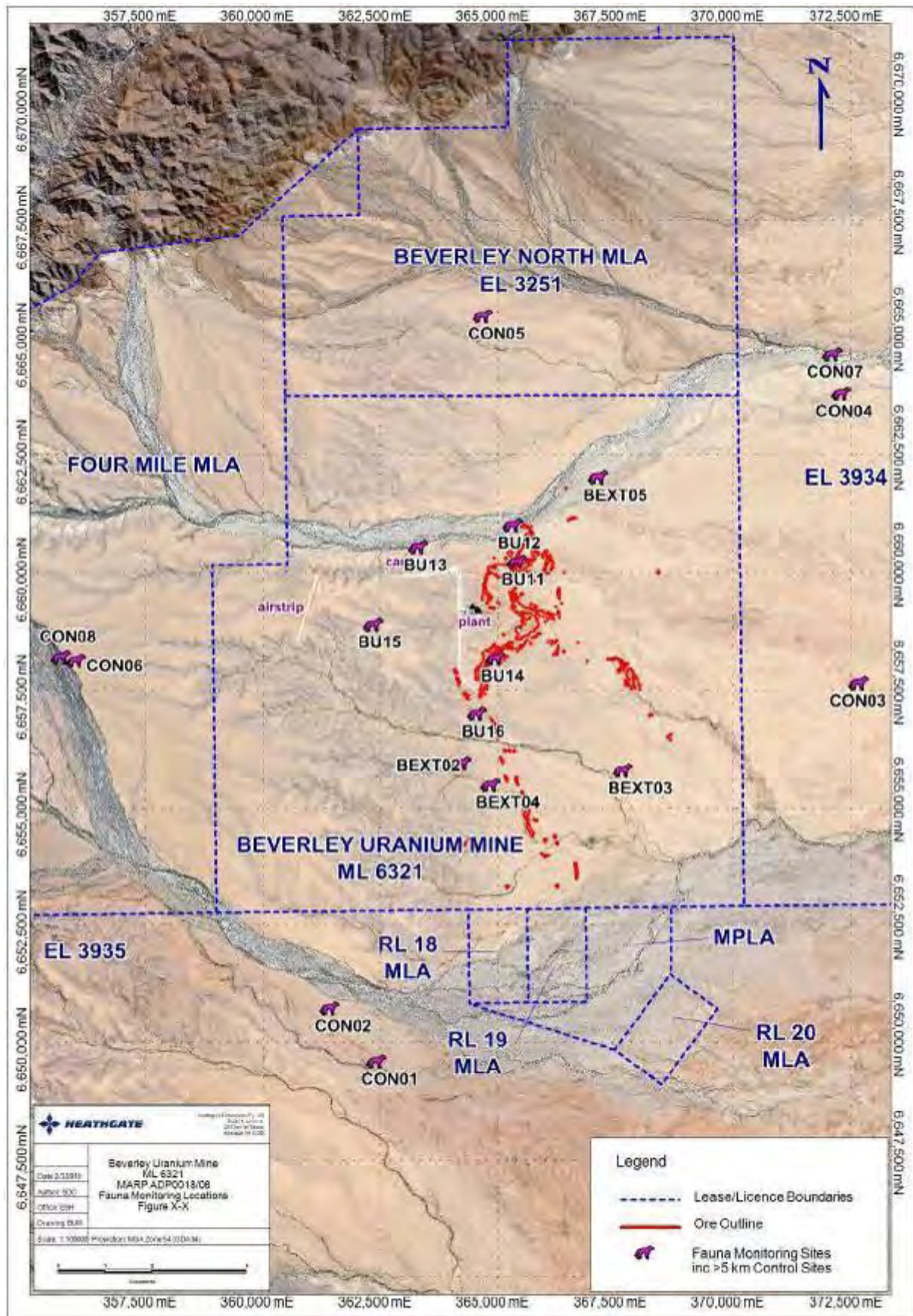


Figure 3-18: Fauna monitoring locations

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3.7 Air Quality

Table 3-10 outlines the regulatory monitoring requirements together with the status of compliance.

Table 3-10: Environmental Monitoring Requirements and Compliance Status – Air Quality

Location	Method	Parameter	Frequency	Compliance Status
Ponds, Processing Plant and Camp / Accommodation areas	Uranium dust and radon decay products	Monitored doses are calculated and are within applicable limits as defined under the RPC Act 1982	Weekly	Compliant

The estimated radiation doses to both employees and public remained low and within the applicable limits defined under the RPC Act 1982. The average dose received by an employee during 2009 was 0.22 mSv and the maximum was 2.98 mSv, well below the applicable dose limit. Employee average and maximum dose for 2001 to 2009 are shown in Figure 3-19.

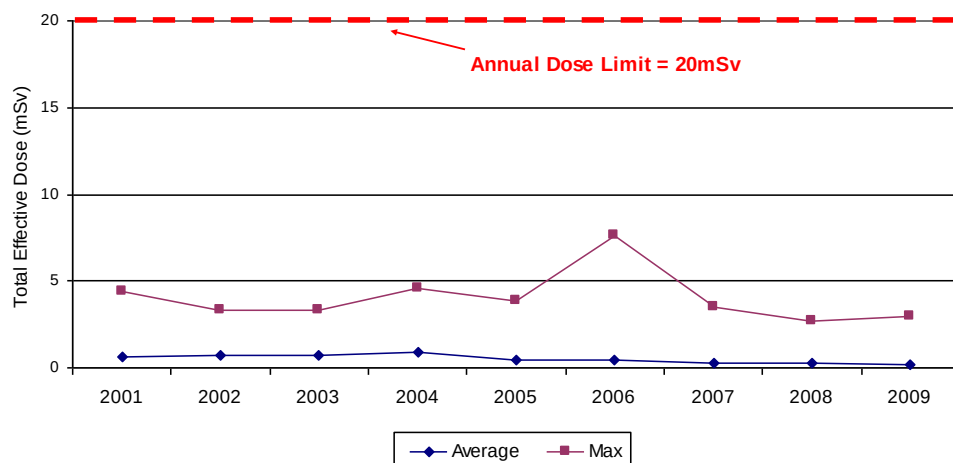


Figure 3-19: Employee dose from 2001 to 2009

The estimated dose to a person living at the accommodation camp is 0.07 mSv (excluding the contribution from natural background radon). Table 3-11 shows the separation of dust and radon dose in mSv. The nearest residence occupied by a member of public is the North Mulga Outstation and considering the distance from Beverley Mine area the annual dose received by a person living there will be less than 0.07 mSv, well below the applicable annual dose limit of 1 mSv.

Table 3-11: Public dose details

	Dose (mSv)
Dust dose (including natural background)	0.015
Radon dose (excluding background)	0.053
Total dose for 2009	0.07
Public Dose limit (annual)	1.00

During 2009 a number of compliance actions were achieved under an Environment Improvement Program with requirements of condition 310-152 of Licence regarding modelled ground level concentrations of nitrogen dioxide and carbon monoxide meeting certain guidelines. Generator modifications and design, construction and installation of exhaust stacks were commissioned in December and a photo of the exhaust stacks is shown below (Plate 3-7)



Plate 3-7: Gas fired generator exhaust stacks installed and commissioned

3.8 Heritage

A Native Title Mining Agreement for ML 6321 was approved by the Adnyamathanha community on 21 October 2007 and was subsequently signed by the appropriate community representatives. This agreement was entered in the mining Native Title Register pursuant to section 63ZBA of the *Mining Act* 1971 on 2 April 2008.

Aboriginal heritage issues are of very high importance to the Native Title Holders and to Heathgate. All heritage sensitive sites are clearly recorded and a report is generated after every clearance survey.

Two heritage surveys were conducted in 2009. A map is updated after each survey by Heathgate's cartographer for internal purposes only as the Aboriginal people wish that the location of these sites not be revealed externally. Selected locations are protected by flagging (fencing) to avoid disturbance and the relevant flagged areas on ML 6321 were checked for disturbance by Heathgate personnel since the 2008 MARP approval and no disturbance had taken place.

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Table 3-12: Environmental Monitoring Requirements and Compliance Status - Heritage

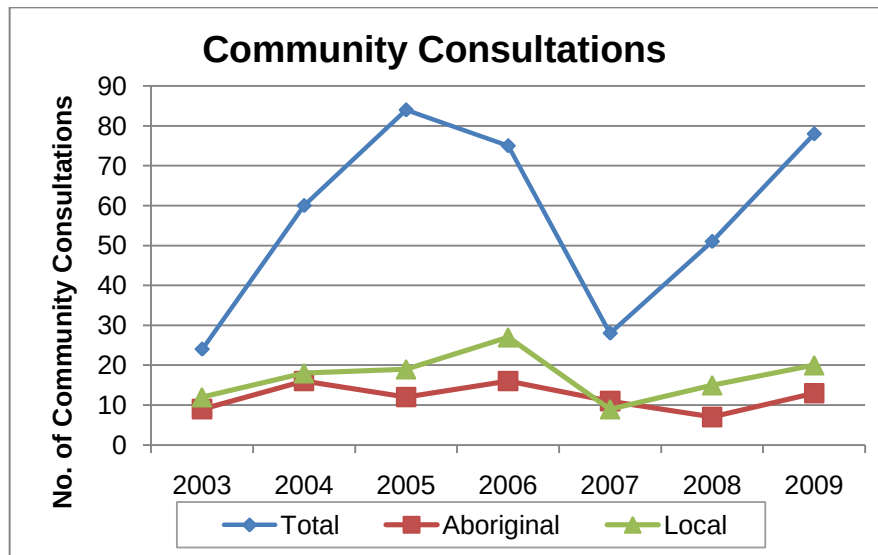
Location	Method	Parameter	Frequency	Compliance Status
ML and Local Area	All Heritage sensitive areas are clearly recorded after every clearance survey	Updated map	After each Aboriginal Clearance survey	Compliant – map is not available publicly
	Survey of flagged areas for disturbance	Number of flagged areas which have been disturbed	6 monthly	Compliant – no disturbance of flagged areas

3.9 Ongoing Community Engagement Plan

Seventy five separate community consultations were recorded in Heathgate's community consultation database for 2009, all having favourable outcomes. The number of community consultations for each quarter is shown in **Error! Reference source not found.** while a graph representing the comparative annual community consultations is given as **Error! Reference source not found.** Heathgate reports community consultations to State regulators each quarter in the Quarterly Environment and Radiation Report.

Table 3-13: Quarterly Community Consultations for 2009

2009	Community Consultations
1st Quarter	10
2nd Quarter	34
3rd Quarter	20
4th Quarter	14

**Figure 3-20: Community Consultations**

Heathgate personnel presented papers or talks at a number of conferences or public meetings during 2009. This included:

- Northern Yorke Peninsula Rotary Club, Kadina, 24 February 2009
- AusIMM International Uranium Conference, Darwin, 10-11 June 2009

- International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2009)", Vienna, Austria, 22–26 June 2009
- Industry Capability Network South Australia, Adelaide, 28 July 2009
- Northern Regional Development Board Forum, Coober Pedy, 14 October 2009
- Mineral Council of Australia 2009 Sustainable Development Conference, Adelaide. 26-30 October 2009
- SA Explorers' Conference, Adelaide, 27 November 2009

Heathgate personnel also authored a small article published in the American Journal 'Environmental Science and Technology' (Woods et al. 2009)

3.9.1 Third Party Complaints

There were no formal third party complaints in 2009.

3.10 Radiological Aspects

Radiological aspects of environmental protection at Beverley have been discussed in various sections and are also included at the end of Table 6-4 of the MARP (refer Appendix A) which provides reference to the appropriate specific identifier where that radiological issue is considered.

Heathgate reports on occupational radiation on a quarterly basis to the regulators and has provided an annual report (Annual Occupational Radiation Monitoring Annual Report – 2009) to the Radiation Protection Division of the Environmental Protection Authority.

Heathgate reiterates that it does and will conduct all operations in a safe and responsible manner and together with general safety, places the radiological safety of the public including workforce (employees and contractors) and the protection of the environment ahead of commercial considerations, based on the appropriate limits and guidelines relevant to its licences to operate.

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4 REHABILITATION

Rehabilitation of the northern wellfield continued throughout 2009. Removal of surface materials and infrastructure such as old fencing and some shallow buried infrastructure continued. The commencement of well rehabilitation in North Wellfield also occurred with 84 production wells being cemented up and the well casings cut below surface as planned.

Mining continued in the other Wellfields and in some instances, further exploration, and as a result no wellfield rehabilitation occurred other than in North Wellfield.

In order to gain better access to areas north of Four Mile Creek a new section of road was installed between the old drillers' laydown and the existing track through Four Mile Creek was upgraded. This enabled rehabilitation to occur to a section of road no longer required between the Old Camp Bore tanks and the track through Four Mile Creek.

The area where the old camp that serviced the FLT was located is showing promising signs of rehabilitation as can be seen in Plate 4-1. This area was rehabilitated in early 2002 with the removal of buildings and associated infrastructure and then scarification of the surface.



Plate 4-1: The old FLT camp site showing good rehabilitation progress

For disturbances such as drill pits, temporary access tracks and other temporary infrastructure, the rehabilitation of areas is done soon after these activities have been completed.

The Accommodation Camp, Processing Plant and main roads are more permanent site infrastructure. Rehabilitation at these locations will occur at the completion of the mining operations at Beverley, unless suitable approval to hand certain infrastructure over for other activities on the cessation of mining is received.

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5 SIGNIFICANT ENVIRONMENTAL BENEFIT

This section sets out the status of vegetation clearing at Beverley identifying clearing approved prior to 25 August 2003, which is not subject to Significant Environmental Benefit (SEB) compensation, and clearing approved after that date which is subject to SEB. An SEB reconciliation was undertaken comparing actual cleared at the end of 2009 to the projections given in the 2008 MARP plus actual rehabilitation that was undertaken to the end of 2009.

There are two main vegetation types cleared at Beverley:

- Mitchell grass plain (currently small chenopods dominate) – the majority of clearing
- Minor drainage lines.

The clearing that occurred during 2009 included

- Four Mile contractors' camp
- Loggers' shed and compound
- Core cutting compound
- Stores shed and compound
- Extension to the plant car park
- Widening of road through Four Mile Creek
- E&D camp storage area
- Wellfields (South, Deep South, Beverley East – partially cleared as most infrastructure is surface run)
- Waste facilities

Badman (2007) outlines the calculation of the SEB ratio needed to calculate compensation for vegetation cleared. Based on his assessment and as previously negotiated with PIRSA, Heathgate has adopted a basic SEB ratio of 4:1 for vegetation clearance associated with its operations. The reduction in ratio from the maximum is based on extensive historic grazing impacts on Wooltana station, the presence of some weeds and disturbance by pastoral tracks, fencelines and historic minerals exploration.

For areas that will be rehabilitated (i.e. wellfields, trunklines, etc) the allowed discount of 50% has been claimed, resulting in a final SEB ratio of 2:1. There are some areas of clearing that may be retained long term, such as the airstrip, although clearing for such infrastructure was approved prior to the requirement for SEB.

Figure 5-1 shows pre-SEB approved areas and relating to SEB reconciliation for 2008 and 2009. Clearing to date is estimated to be >90% Mitchell Grass plains. The majority of pre-SEB clearance was approved as part of the initial EIS and MARP process in 1998/99, with some minor areas approved by means of MARP amendments up to 25 August 2003.

Prior to 2004, wellfields were cleared and topsoil removed and stockpiled adjacent to the wellfield for later resspreading. This had been considered best practice. However, two observations were made suggesting this was not the best approach for Beverley:

- Volunteer vegetation was establishing in cleared areas
- Topsoil stockpiles suffered wind erosion losses.

From 2004, topsoil and its associated vegetation have not been deliberately removed from the majority of the area of wellfields. Drill pits have topsoil removed which is then replaced within weeks with vegetation removed retained adjacent to the area for habitat purposes. Topsoil is stockpile adjacent tracks that require grading.

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The area actually cleared for wellfields established since 2004 is calculated as follows:

$$(\text{Area between wells} \times 1.2) \times 0.8$$

Where 1.2 is an enlargement factor to allow for minor roads and tracks, and 0.8 is estimated to be a factor to allow for partial clearing. Based on Figure 5-1, the life-of-mine SEB-liable clearing is 260 ha. This compares to the pre-SEB clearing approval of 255 ha (Table 5-1).

Table 5-1: Summary of Areas Approved for Clearing (Life-of-Mine)

Type	Clearing approved pre-SEB (ha)	Clearing subject to SEB (ha) – Life of Mine (2008 MARP)	Reconciliation - Actual SEB Clearance to end 2009
Total	255	260	76

In Appendix D of the 2008 MARP discussing SEB, Heathgate indicated its preference to provide local SEB by a private arrangement rather than contribute directly to the Native Vegetation Fund. In late 2008, PIRSA, Heathgate and representatives of the Arkaroola Wilderness Sanctuary met and identified a project within Arkaroola, potentially extending south into the Vulkathunha-Gammon Ranges National Park (VGRNP) that could be suitable as an SEB compensatory project. An area including the Northern Flinders Ranges endemic plant, *Acacia araneosa* or Spidery Wattle, is proposed. Spidery Wattle has a very restricted distribution with contiguous populations on Arkaroola and VGRNP. Spidery Wattle is listed as Vulnerable at a national level (EPBC Act) and Endangered at a state level (NPWSA Act). The main threats to Spidery Wattle's survival in the wild are overgrazing, particularly by goats and rabbits, soil erosion and climate change. The proposed project will address protection from feral herbivores (and indirectly soil erosion). Of importance is that while targeted at *A. araneosa* the SEB compensation area will also enhance protection other vegetation in the area and associated native fauna.

Arkaroola have liaised with National Parks and the NRM board and have support in principal. A formal SEB proposal which included background information and ecological justification was prepared and submitted in 2009. Heathgate anticipate that the project will be fully negotiated, approved and commenced before the end of 2010.

The actual amount cleared to the end of each year will be provided in the corresponding MARCR. The calculation of potential life-of-mine vegetation clearing subject to SEB at Beverley is likely to be an overestimate (Table 5-2). Heathgate anticipates that "spare" SEB compensatory area at the Spidery Wattle project might be used as SEB "credit" and used to offset vegetation clearing and SEB compensation that would be required at other projects including its Beverley North Project currently going through the approval process. -This arrangement will be formalised at the appropriate time, subject to acceptance from PIRSA and the Native Vegetation Council.

Table 5-3 shows the SEB reconciliation to the end of 2009 with actual SEB compensation area being 152 ha. The SEB reconciliation that occurred for the 2008 period and was presented in the 2008 MARCR and the SEB reconciliation for the 2009 period is set out in Table 5-2.

Rehabilitation to a section of road no longer required between the Old Camp Bore tanks and the track through Four Mile Creek occurred during 2009. Prior to 2009 the Clay Batching Pad area used to make the clay for construction of the walls of the Pregnant Liquor Pond and Evaporation Pond 5 was rehabilitated, but the area not quantified in the 2008 MARCR. These two rehabilitated together represent in total 11 ha.

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Table 5-2: SEB Calculation (Life-of-Mine)

Type	Area Cleared (ha)	Initial Ratio	Final Ratio*	SEB Area (ha)
Total	260	4:1	2:1	520

* Using a 50% discount for areas that will be revegetated.

Table 5-3: SEB Reconciliation (to end 2009)

Type	Area Cleared (ha)	Initial Ratio	Final Ratio*	SEB Area (ha)
Total	76	4:1	2:1	152

* Using a 50% discount for areas that will be revegetated.

Table 5-4: SEB Summary Table

	Last reporting period (ha)		Current reporting period (ha)		Proposed next 12 months (ha)	
Type	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)
Total	54	0*	22	11	10	5

* As discussed in the text some SEB-liable areas were rehabilitated prior to the end of 2008 but not quantified; the rehabilitation area for the current reporting period includes all SEB-liable cleared areas rehabilitated to the end of 2009.

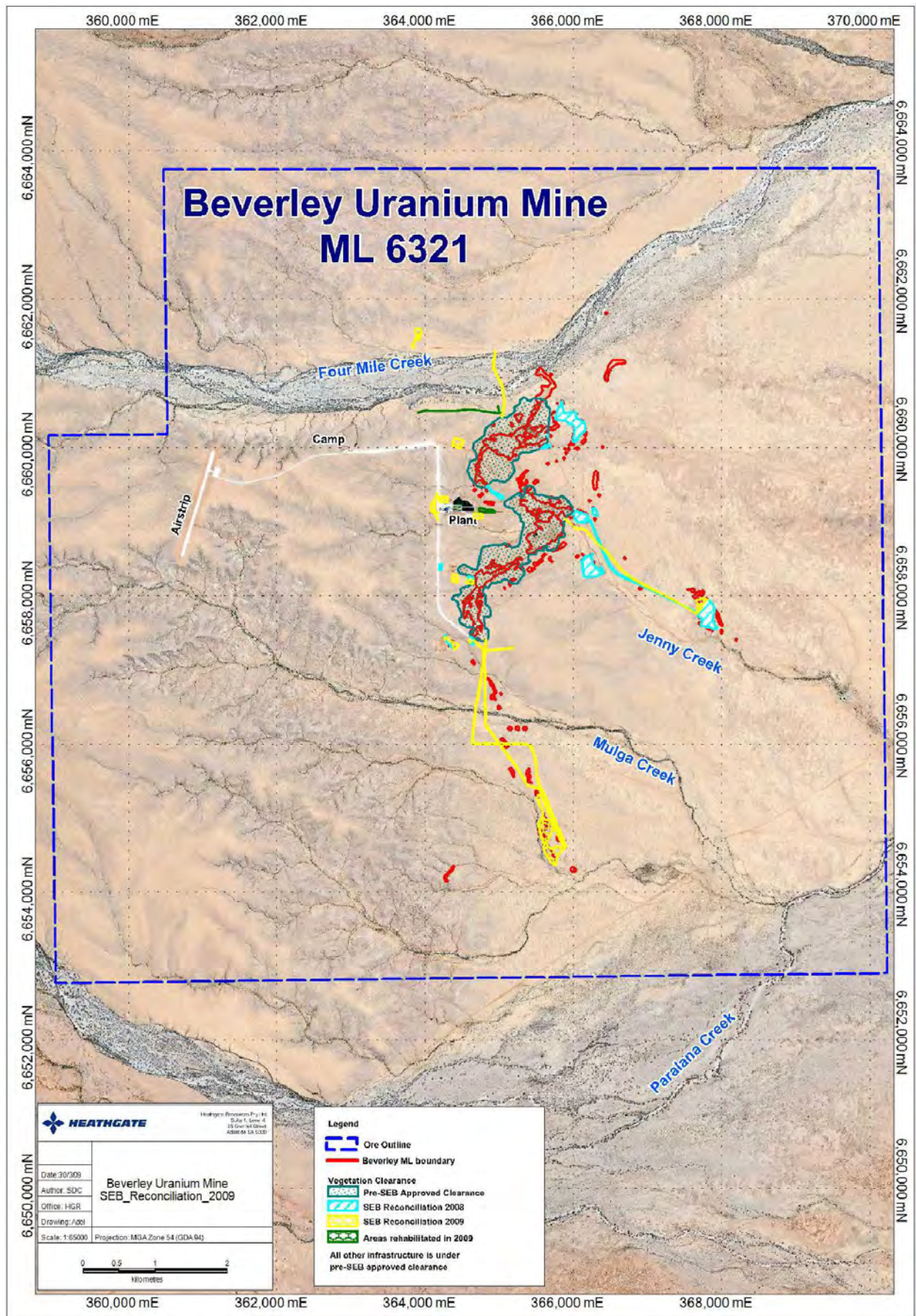


Figure 5-1: SEB Reconciliation Map

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6 COMPLIANCE WITH STATE AND FEDERAL CONDITIONS

Table 6-1 below demonstrates Heathgate's compliance with both State and Commonwealth approval conditions and reporting requirements including those of the Environmental Protection and Biodiversity Conservation Act for ML 6321.

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Table 6-1: Summary of approval obligations

Obligation Origin	Condition		Status of Obligations
State (PIRSA) Approval: First Schedule	1	Mining operations authorised by this lease must be only for the recovery of Uranium.	Compliant
	2	The Lessee must keep accurate records of the quantity, value and manner of disposition of all minerals mined and, whenever required to do so, submit the records for inspection by any person authorised by the Director of Mines.	Compliant. No records requested for inspection.
	3	The Lessee must not conduct any mining operations on the land until a Mining and Rehabilitation Program (MARP) has been approved by the Minister.	2008 MARP approved by PIRSA on 7 October 2008, replacing earlier approved MARP.
	4	The MARP must comply with the requirements of guidelines approved by the Director of Mines and include environmental outcomes and criteria that are developed in consultation with relevant stakeholders.	2008 MARP approved by PIRSA on 7 October 2008, replacing earlier approved MARP.
	5	The Lessee agrees to the approved MARP being made available for public inspection.	The 2008 MARP is available to the public on the PIRSA website. Heathgate will finalise the upgrade of its website in 2010.
	6	The Lessee must demonstrate upon request and to the Director of Mines, the Lessee's capability and competence to comply with the requirements of the <i>Mining Act, 1971</i> , the conditions of this lease and the MARP.	Heathgate considers its record gives good confidence in its ability and competence and will provide further demonstration on the appropriate request from the Director of Mines.
	7	The Lessee accepts that the Director of Mines may withdraw a MARP approval if, in the Director's opinion, the Lessee has not complied with the approval, or has not demonstrated satisfactory capability to comply with the approval.	The MARP approved by PIRSA on 7 October 2008 remains valid.
	8	The Lessee must provide to the Director of Mines, a Mining and Rehabilitation Compliance Report (MARCR) on operations carried out on the lease and compliance with the approved MARP. The MARCR must be submitted every year, within 3 months after the anniversary of the date the lease was granted, or at some other time agreed with the Director of Mines in accordance with guidelines approved by the Director of Mines. The Lessee agrees to the MARCR being made available for public inspection.	The 2008 MARCR was submitted on 31 March 2009 and is available on the PIRSA/SARIG website. Heathgate will finalise the upgrade to its website in 2010.
	9	The Lessee must, if requested by the Director of Mines, undertake an independent audit of achievement of the environmental outcomes in the MARP, by an independent expert approved by the Director of Mines. The audit will be made available to the public, in a manner and form as determined by the Director of Mines.	An internal audit was undertaken in February 2010 covering the 2009 calendar year and a summary is appended to this MARCR. Heathgate will undertake an external audit in 2011.
	10	The Lessee must provide to PIRSA a Mine Completion Report prior to lease relinquishment, in accordance with guidelines approved by the Director of Mines.	Mining not completed.

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Obligation Origin	Condition		Status of Obligations
State (PIRSA) Approval: First Schedule (cont)	11	The Lessee must, prior to commencing operations under this lease and for the duration of the lease maintain public liability insurance to cover all operations under the lease in the name of the Lessee for a sum not less than \$50 million or such greater sum as specified by the Director of Mines and make such amendments to the terms and conditions of the insurance as the Director of Mines may require. A copy of the cover note of certificate of currency for the insurance must be provided to the Director of Mines upon request. If requested by the Director of Mines, the Lessee must engage a independent and reputable risk assessor to prepare a risk assessment report detailing the public liability risks arising out of the conduct of mining operations on the lease and recommending the level of amount of public liability cover (in respect of any one occurrence) that should be effected and maintained by the lessee. In preparing the risk assessment report, the assessor must consult with the landowner and the Director of Mines. In specifying the level of insurance required, the Director of Mines accepts no liability for the completeness, adequacy of the sum insured, the limit of liability, the scoped coverage, the conditions or exclusions of the insurance in respect of how the Lessee may or may not respond to any loss, damage or liability.	Compliant.
	12	The Lessee must report any non-compliant criteria that demonstrate a breach of the environmental outcomes to be achieved (as detailed in the MARP) to the Director of Mines. A report must be provided after the Lessee becomes aware of the non-compliance, by the close of the next business day or such time period as specified in the MARP.	Compliant
	13	The Lessee must, before commencing operations under this lease, lodge a bond in accordance with the Mining Act, 1971 of such an amount of the surety as determined from time to time by the Minister, to cover the full cost of rehabilitation liability assessed by an independent third party at any time. In requesting a review of the bond, the Minister may request that written quotes from a third party are obtained by the lessee for the cost of rehabilitating the site to the requirements specified in the approved MARP. The Lessee must meet all the charges and costs in obtaining and maintaining the Bond.	Compliant - a full review of the financial securities bond was undertaken by HGR and sent to PIRSA on 29 May 2009.
State (PIRSA) Approval: Second Schedule - Soil	1	The Lessee must in constructing and operating the lease ensure that soil affected by mining activities is suitable for a return to pastoral use.	Compliant - fulfilled through MARP obligations.

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Obligation Origin	Condition		Status of Obligations
State (PIRSA) Approval: Second Schedule - Waste disposal and hazardous substances	2	The Lessee must, in constructing and operating the lease ensure that there is no contamination of land and soils either on or off the site caused by waste products and hazardous materials used in the mine operations.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Waste disposal and hazardous substances (cont)	3	The Lessee must in constructing and operating the lease ensure that there are no adverse impacts to the environment due to radon release, uranium-bearing materials, or radiological aspects of seepages and spills.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Vegetation	4	The Lessee must, in constructing and operating the lease ensure no loss of abundance or diversity on or off the Beverley mining lease to native vegetation through clearance or any other damage unless prior approval under the relevant legislation is obtained.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Weeds and Pests (feral animals)	5	The Lessee must in constructing and operating the lease ensure no introduction of new weeds, plant pathogens or pests (including feral animals), nor increase in abundance of existing weed or pest species in the lease area compared to adjoining pastoral properties.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Stormwater	6	The Lessee must in constructing and operating the lease ensure no compromise of pastoral use of downstream surface water bodies.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Groundwater	7	The Lessee must, in constructing and operating the lease ensure that there is no compromise to other existing Great Artesian Basin users within the Beverley mine region.	Compliant - fulfilled through MARP obligations.
	8	The Lessee must, in constructing and operating the lease ensures that there is no compromise to pastoral use of the Willawortina aquifer.	Compliant – fulfilled through MARP obligations - noting that most Willawortina wells on the lease do not meet stock water quality guidelines (Section 6.5.8.4 of the MARP)
	9	The Lessee must, in constructing and operating the lease ensure that there is no compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Native Fauna	10	The Lessee must in constructing and operating the lease ensure that there are no net adverse impacts from the site operations on native fauna abundance or diversity in the lease area and in adjacent areas.	Compliant - fulfilled through MARP obligations.

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Obligation Origin	Condition		Status of Obligations
State (PIRSA) Approval: Second Schedule - Aboriginal and European Heritage	11	The Lessee must in constructing and operating the lease, ensure that there is no disturbance to Aboriginal artefacts or sites of significance unless prior approval under the relevant legislation is obtained.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Fire	12	The Lessee must in constructing and operating the lease ensure that there are no uncontrolled fires caused by mining operations.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Unauthorised Access	13	The Lessee must in constructing and operating the lease ensure that there are no public injuries and or deaths resulting from unauthorised entry to the site that could have been reasonably prevented.	Compliant - fulfilled through MARP obligations.
State (PIRSA) Approval: Second Schedule - Landholder Liaison	14	Where the pastoral lease holder differs from the mining lease holder, the Lessee must ensure that the occupier of the land is fully advised of their program of activities, particularly in regard to the impact of operations on the land and rehabilitation progress.	Heathgate is the relevant pastoral lease holder.
State (PIRSA) Approval: Second Schedule - Infrastructure	15	The Lessee must, in constructing and operating the lease, ensure that there is no unauthorised damage to adjacent public or private infrastructure.	Compliant
State (PIRSA) Approval: Second Schedule - Closure and Rehabilitation	16	The Lessee must demonstrate prior to lease expiry or surrender that the following outcomes (in so far as they may be affected by mining operations) will be achieved indefinitely post mine closure to the satisfaction of the Director of Mines.	Mining not completed.
	16a	No change, outside of natural background variation, to the water quality of the GAB.	Mining not completed.
	16b	No change, outside of natural background variation, to the water quality of the Willawortina Formation.	Mining not completed.
	16c	No compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	Mining not completed.
	16d	The external visual amenity of the site is acceptable to relevant stakeholders.	Mining not completed.
	16e	Risks to the health and safety of the public and fauna are as low as reasonably achievable.	Note: with respect to radiological risks to fauna, it is deemed that the ALARA protection of the public means that fauna are similarly protected. Mining not completed.
	16f	Ecosystem and landscape function is resilient, self-sustaining and indicating that the pre-mining ecosystem and landscape function will ultimately be achieved	Mining not completed.

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Obligation Origin	Condition		Status of Obligations
	16g	All waste materials left onsite are chemically and physically stable	Mining not completed.
State (PIRSA) Approval: Second Schedule - Leading Indicators	17	The MARP must include additional leading indicator criteria for the following outcomes.	
	17a	Ensure that soil affected by mining activities is suitable for a return to pastoral use.	Compliant – leading indicator criteria included in the approved MARP.
	17b	Ensure that there is no compromise to other existing Great Artesian Basin users within the Beverley mine region.	Compliant – leading indicator criteria included in the approved MARP.
	17c	Ensure that there is no compromise to pastoral use of the Willawortina aquifer.	Compliant – leading indicator criteria included in the approved MARP.
	17d	Ensure that there is no compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	Compliant – leading indicator criteria included in the approved MARP.
Federal Approval Conditions	1	The person taking the action must ensure that, in undertaking the action, the following outcomes are achieved (in so far as they may be affected by mining operations):	
	1(a)	No compromise to other existing Great Artesian Basin users within the Beverley mine region	Compliant- MARP obligation.
	1(b)	No compromise to pastoral use of the Willawortina aquifer.	Compliant, noting that most Willawortina wells on the lease do not meet stock water quality guidelines (Section 6.5.8.4 of the MARP) – MARP obligation.
	1(c)	No compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	Compliant – leading indicator criteria included in the approved MARP.
	1(d)	No loss of abundance or diversity on or off the Beverley mining lease to native vegetation through clearance or other damage unless prior approval under relevant legislation is obtained.	Compliant- MARP obligation.
	1(e)	No net adverse impacts from the site operations on native fauna abundance or diversity in the lease area and adjacent areas.	Compliant- MARP obligation.
	1(f)	No introduction of new weeds, plant pathogens or pests (including feral animals), or increase in abundance of existing weed or pest species in the lease area compared to adjoining pastoral areas.	Compliant- MARP obligation.
	1(g)	No uncontrolled fires caused by mining operations.	No fires have occurred outside the processing plant fenced area.
	1(h)	No disturbance to Aboriginal artefacts or sites of significance unless prior approval under the relevant legislation is obtained.	No heritage listed sites on ML 6321.
	1(i)	No compromise of pastoral use of downstream surface water bodies.	Compliant- MARP obligation.

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Obligation Origin	Condition		Status of Obligations
	1(j)	Soil affected by mining activities is suitable for return to pastoral use.	Bioremediation bays are in use and soil testing for reuse is planned for 2010. Scanning of soils for surface contamination occurs.
	1(k)	No adverse impacts to the environment due to radon release, uranium-bearing materials, or radiological aspects of seepages and spills.	Compliant- MARP obligation.
	1(l)	No contamination of land and soils either on or off the site caused by waste products and hazardous materials used in the mine operations that would compromise a return to pastoral use.	Compliant- MARP obligation.
	2	The person taking the action must develop a Monitoring Plan to measure the achievement of each outcome in Condition 1. The Monitoring Plan must specify:	The Monitoring Plan exists as Chapter 6 of the MARP.
	2(a)	criteria to demonstrate the clear and unambiguous achievement of the outcomes specified above	Compliant.
	2(b)	the parameters to be monitored	Compliant.
	2(c)	how frequency of monitoring will be determined	Compliant.
	2(d)	the responsibility for interpreting the monitoring results	Compliant. Results will be interpreted by appropriate environmental specialists, either external or internal to Heathgate and documented in the MARCR. The 2009 results are provided in this MARCR.
	2(e)	the threshold triggers and the response activities	Compliant.
	2(f)	an outline of control and management strategies that may be used to achieve the groundwater outcomes in Condition 1	Compliant.
	2(g)	reporting arrangements to management, external stakeholders and the public, including procedures for reporting non-compliance	Compliant.
		The action cannot commence until the Monitoring Plan is approved by the Minister. The approved Plan must be implemented.	Compliant. The monitoring plan was integrated into the MARP and approved by the Minister on 11 November 2008.
	3	The person taking the action must develop a Mine Closure and Completion Plan. The Plan must demonstrate that the following outcomes, in so far as they may be affected by mining operations, will be achieved indefinitely post mine closure:	
	3(a)	No change, outside of natural background variation, to the water quality of the Great Artesian Basin.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes this condition (3a).

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Obligation Origin	Condition		Status of Obligations
	3(b)	No change, outside of natural background variation, to the water quality of the Willawortina formation.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes condition 3(b).
	3(c)	No compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes condition 3(c).
	3(d)	Risks to the health and safety of the public and fauna are as low as reasonably achievable.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes condition 3(d) with respect to radiological risks to fauna, it is deemed that the ALARA protection of the public means that fauna are similarly protected.
	3(e)	Ecosystem and landscape function is resilient, self-sustaining and indicating that the pre-mining ecosystem and landscape function will ultimately be achieved.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes condition 3(e).
	3(f)	All waste materials left onsite are chemically and physically stable.	Compliant. The Mine Closure and Completion Plan was integrated into this MARP and includes condition 3(f).
		The action cannot commence until the Mine Closure and Completion Plan is approved by the Minister. The approved Plan must be implemented.	Progressive rehabilitation will be documented in this MARCR. A Mine Closure and Completion Plan was approved by the Minister on 11 November 2008. A formal Closure Plan will require the Minister's approval.
	4	The person taking the action must prepare a Community Engagement Plan to enable open dialogue with stakeholders on compliance with the approval conditions. The action cannot commence until the Plan is approved by the Minister. The Plan must be implemented.	The Community Engagement Plan is integrated into the MARP and approved by the Minister on 11 November 2008.
	5	Within 14 days of commencement of the action, the person taking the action must advise the Department of the actual date of commencement.	Heathgate notified commencement of mining operations in Beverley Deep South on 1 June 2009.
	6	Within three months of the anniversary of the date of commencement of the action and each year after, the person taking the action must provide a report to the Department addressing compliance with the conditions of this approval. Annual reports must be provided until the Minister is satisfied that the proponent has complied with all conditions of the approval.	Compliant - the 2009 MARCR is available on PIRSA's website. The MARCRs are based on the calendar year and provided by 31 March of the following year.
	7	If at any time after five years from the date of this approval, the Minister notifies the person taking the action in writing that the Minister is not satisfied that there has been substantial commencement of the action, the action must not thereafter be commenced without the written agreement of the Minister.	Compliant - Heathgate commenced mining in Beverley Deep South in June 2009.

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Obligation Origin	Condition		Status of Obligations
	8	Upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	Compliant - an internal audit took place in March 2009. A routine independent audit will occur in 2010. No direction to undertake an external audit has been received.
	10	If the Minister believes that it is necessary or desirable for the better protection of the environment to do so, the Minister may request the person taking the action to make specified revisions to the plan approved pursuant to Conditions 2, 3 and 4 and to submit a revised plan for the Minister's approval. The person taking the action must comply with any such request. If the Minister approves the revised plan pursuant to this paragraph, the person taking the action must implement this plan instead of the plan originally approved.	Heathgate believes the regular regulator discussions (quarterly with State regulators and six-monthly State and Federal regulators) will mean any such revisions will be made progressively with consultation.
	11	The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the above conditions of approval and make them available upon request to the Department. Such records may be subject to audit by the Department and used to verify compliance with the conditions of approval.	Compliant – all records being maintained.
Licence to Mine and Mill Conditions State EPA – Radiation Protection Branch	1	The Licensee shall comply with the “Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)”: Radiation Protection Series No 9; ARPANSA (August 2005), and any amendments thereof or any codes, standards or recommendations substituted therefore.	Compliant.
	2	This licensee shall submit to the Environment Protection Authority, together with the application for renewal: 1. A plan showing areas in which new wellfield development is planned in the next licence period; 2. Any significant changes in the plant layout, major equipment or processes introduced during the preceding period; 3. Estimates of the quantities of wastes produced in the previous licence period	Submitted with renewal as required

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7 RECTIFICATION OF NON-COMPLIANCES

7.1 Soil Sampling

Soil sampling of sites S11 to S18 has occurred albeit late however the non-compliance is with timing not with lack of soil sampling done. Soil samples were taken in 2009 for sites S1-S10 (refer Section 3.2) however sites S11 to S18 that were implemented due to the extension of the mining zone were inadvertently not sampled at the same time. To rectify this situation, soil sampling occurred at S11 to S18 in the February 2010 as soon as the situation was realised and these sites and their coordinates have been added to the soil sampling form. Sampling results for S11 to S18 will be included in the 2010 MARCR.

8 MANAGEMENT AND SYSTEM REVIEW

An internal audit on Heathgate's compliance with the 2008 MARP and ML 6321 licence conditions was undertaken during February 2010.

This audit was undertaken primarily by Ping Goodwin, Environment Advisor and then supported by David Hunt, Environment Advisor and Sue Carter, Senior Environment Advisor. The results including commendations from the audit, non-conformances and areas requiring improvement and recommendations noted are outlined in Appendix H.

9 FITNESS-FOR-PURPOSE REVIEW OF PLANT, EQUIPMENT, INFRASTRUCTURE AND OTHER FACILITIES

Beverley Mine Site has a Mex Ops system in place which brings up service requests and dates for rechecking of equipment. An incident report system, InControl, is utilised to action maintenance and repairs that are required to plant equipment at any time other than at regular maintenance checks. The entire project was subject to a thorough risk assessment prior to the lease extension in 2007. All new major new equipment or facility is subject to a Hazard and Operability Study (HAZOP) analysis.

10 NEW ENVIRONMENTAL HAZARDS

No new environmental hazards became evident or apparent during 2009.



Plate 10-1: Orange Chats (*Epthianura aurifrons*) frequent the Beverley area.

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11 INCIDENTS

11.1 Incidents

A total of 398 incidents including 168 hazards were recorded on Heathgate's internal system, InControl, during the 2009 reporting period. This increase from a total of 279 in 2008 can be, in part, attributed to the more diligent reporting by personnel following compulsory education and training with regard to reporting all incidents and hazards. Note that near misses have increased from 3 to 23 as these are also being reported more diligently. The implementation of morning toolbox meetings for all departments on site with the main focus on safety has also seen an increase in reporting. The incidents have been classified into the following categories:

- Environmental
- Property Damage
- Quality/Production
- Hazard
- Occupational Health & Safety
- Injury, First Aid Treatments, Fatality
- Near Miss
- Lost Time injury (LTI)

Table 11-1: Categorised incidents for 2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Environmental	2	4	9	7	2	3	3	4	2	4	3	7	50
Property Damage	1	1	1	4	3	3	4	8	8	3	3	2	41
Quality/Production	1		3		1		1	5	5	3	3	3	25
Hazard	4	7	18	4	16	16	29	21	11	16	16	10	168
OHS		2	3	3	2	1	3	2			4	1	21
Injury, First Aid Treatments, Fatality		4	4	5	3	11	11	5	3	6	10	8	70
Near Miss		2	1		1	2	10	2	1	2	2		23
LTI*		1	0	1	1		1	2			1	1	8
TOTAL	8	20	39	23	28	36	61	47	30	34	41	31	398

*LTIs are already recorded in the Injury, First Aid Treatments, Fatality category. There were no fatalities.

11.1.1 Corrective Actions

All incidents require the generation of an incident report which is logged into the Heathgate's incident and hazard database. Weekly meetings are held to discuss the corrective actions which are put into place when the incidents are logged into the database.

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12 OTHER

12.1 Public Liability Insurance

Public liability insurance for the site is current and a copy of the Certificate of Currency is available to be shown to PIRSA on request.

12.2 MARP Amendments

One application for amendment to the 2008 MARP ADP0018/08 occurred during May 2009 for construction of Stage 2 of the Four Mile Construction Camp and a section of road and power line to the proposed Beverley Four Mile Project on ML 6321. This MARP amendment was approved by PIRSA on 19 June 2009 (Ref: M06837001).

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APPENDIX A: MARP Table 6-4 - Potential Impact Events, Risks, Management, Outcomes and Measurement – Mining

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Table 6-4: Potential Impact Events, Risks, Management, Outcomes and Measurement - Mining

ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	SOILS							
1.1	Chemical and radiological contamination ¹ of soil and watercourse sediments that would prevent its return to pastoral use arising from: a. seepage from water management ponds through construction defects, wear and tear and accidental damage. b. pond overflows of mining solutions and waste disposal solution due to high rainfall events or control system failure. c. the escape of mining solution due to accidental breakages of piping from poor welds, vehicle damage or pipe defects.	Likelihood: Possible Consequence: Moderate Risk: HIGH	Pressure testing of all pipework prior to commissioning. Ponds lined with plastic or clay. Leak detection system beneath ponds. Wellhead drip trays. Bunds around processing plant and operational mining areas. Protection of piping from traffic in key areas. Refer RWMP.	Wellfields are continually checked by Wellfield Operators and Maintenance personnel. Soils that are radiologically affected above the operational contamination criteria will be buried according to the RWMP. Leaks in double-lined ponds above the TALR will be repaired. Leaks in ponds 1-4 will be repaired based on visual observations. Continuous pressure monitoring of trunklines Continuous flow monitoring of wellhouses. Monitoring of drip trays.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Soil affected by mining activities is suitable for return to pastoral use.	For a, only rehabilitation criteria apply (See Section 7). b, c All sites subject to spills meet radiological criteria ⁷ as defined in the RWMP.	a. Leakage from double-lined ponds is compared to the Target Action Leakage Rate (TALR) of 22 mL/m ² /day ² . b. water levels in ponds are checked at least weekly and after >10 mm of rainfall in a day and maintained at least 0.20 m below lowest level of rim. c. any leaks detected by automatic systems or visual observation are logged as events and rectified.

¹ Chemical and radiological contamination are intrinsically linked and radiological is the primary indicator.

² See section 6.5.7.2 for an explanation of the TALR.

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
1.2	Spillage of hazardous substances during transport, storage and handling resulting in contamination of soil that would prevent its return to pastoral use.	Likelihood: Possible Consequence: Minor Risk: MODERATE	Hazardous materials and fuel stored in bunded areas.	Undertake routine inspection of tanks and equipment used to store and transfer chemicals and process materials. Any deficiencies in the integrity of any equipment discovered by the inspection will be brought to the attention of senior site management for appropriate corrective action. Implement and regularly update spill and emergency response procedures, maintain spill kits and train ERT personnel. Implement and regularly update standard operating procedures for handling of chemicals. Fuel-affected soil removed for landfarming and later disposal (if required). Acid or alkali spills remediated (if required).	Likelihood: Rare Consequence: Minor Risk: LOW	Soil affected by mining activities is suitable for return to pastoral use.	Spills of hazardous materials are assessed and if so determined cleaned up: a) Diesel spills to site specific criteria to be established using NEPM Risk Assessment methodology as recommended by EPA. b) Acid or alkali spill sites returned to within local background range of pH.	Number and nature of spills and cleanups

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
1.3	Soil disturbance due to excessive off-road vehicle movement which may compromise rehabilitation for later pastoral use resulting from: • compaction of soil • exacerbated erosion.	Likelihood: Possible Consequence: Minor Risk: MODERATE	Provide stabilised tracks or roads for areas with frequent traffic. Provide fencing in key areas to keep vehicles on tracks.	Educate all site employees and contractors on the importance of remaining on existing tracks. Personnel to drive only on existing tracks, unless permitted otherwise via Environmental Clearance Permit. Additional fencing in areas with repeated unauthorised off-road tracks. Progressive closure and rehabilitation of obsolete formed tracks and unauthorised off-road tracks. Ripping of compacted areas and soil when replaced.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Soil affected by mining activities is suitable for return to pastoral use.	Off-road vehicle movements not approved via an Heathgate's Environmental Clearance Permit (ECP) are investigated, reported and one of the following undertaken:: • fenced off to prevent reuse, • rehabilitated, or • converted to an authorised road subject to SEB.	Number of non-compliant ECPs involving off-road incidents

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	VEGETATION							
2.1	Reduction in regional native vegetation species density and diversity due to mining operations.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Minimise perennial vegetation clearing by design: • Fencing patches of vegetation and soaks to protect seed stock and habitat. • Run pipeline on surface. • Wellfield and projects planning.	Enforcement of Environmental Clearance Permit system. Establishment of approved Significant Environmental Benefit compensation where due. Weed control.	Likelihood: Rare Consequence: Minor Risk: LOW	No loss of abundance or diversity on or off the Beverley mining lease to native vegetation through clearance or any other damage unless prior approval under the relevant legislation is obtained.	Demonstrate that all clearing undertaken is approved in accordance with the MARP.	Progressive SEB accounting in the annual MARCR.
2.2	Loss of local native vegetation (habitat) due to clearance for mining operations.	Likelihood: Almost Certain Consequence: Minor Risk: HIGH	Minimise perennial vegetation clearing by design.	Enforcement of Environmental Clearance Permit system. Establishment of approved Significant Environmental Benefit compensation where due. Progressive and final re-vegetation.	Likelihood: Rare Consequence: Minor Risk: LOW	No loss of abundance or diversity on or off the Beverley mining lease to native vegetation through clearance or any other damage unless prior approval under the relevant legislation is obtained.	Demonstrate that all clearing undertaken is approved in accordance with the MARP.	Progressive SEB accounting in the annual MARCR.

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
2.3	Introduction of new or increase in abundance of existing weeds and pests (feral animals) ³ .	Likelihood: Possible Consequence: Minor Risk: MODERATE	'Shake down' (de-dust) area prior to main entrance to ML for incoming traffic to drop seeds.	Flora and fauna surveys to identify trends. Weed control. No pets on Mine Lease. Feral animal control.	Likelihood: Unlikely Consequence: Minor Risk: LOW	No introduction of new weeds, plant pathogens or pests (including feral animals), nor increase in abundance of existing weed or pest species in the lease area compared to adjoining pastoral areas ⁴ .	Flora and fauna surveys demonstrate no new weeds or feral animals (due to mining activities) nor statistically significant ⁵ increase in abundance of existing weed or pest species in the lease area compared to adjoining pastoral areas.	Trends noted in annual vegetation and fauna ⁸ surveys.
2.4	Loss of local native vegetation (habitat) due to mining-related fires.	Likelihood: Possible Consequence: Minor Risk: MODERATE	Fire fighting equipment. Roads/tracks act as fire breaks. Design control measures to be implemented should fuel loads become significant.	Fire-fighting exercises undertaken.	Likelihood: Unlikely Consequence: Minor Risk: LOW	No uncontrolled fires caused by mining operations.	Any fires caused by mining operations are controlled within the ML boundary.	

³ Feral animals and fauna surveys are included here to match condition 5 of Schedule 2 of the lease conditions (Section 8.6). They influence vegetation outcomes.

⁴ Control sites are chosen by qualified and experienced specialists (see text).

⁵ Where such statistical measures are valid. Qualitative assessment by independent specialists is considered more appropriate in some cases. See Section 6.3.8.

ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	SURFACE WATER							
3.1	Watercourse contamination (including radiological) arising from release of mining solution due to flood damage to pipes, ponds and infrastructure, or from high rainfall causing overflow of ponds.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Engineered creek crossings where high opportunity for flood damage is present. Ponds, wellhouses and processing plant located on high ground above 1-in-100 year ARI flood level. Use of 1-in-100 year ARI flood level map in design of pipe routes and flood protection to minimise creek crossings. Minimise production well installation in flood-prone areas.	Visual Inspection around site and review of Flood Management Plan as appropriate. Visual assessment of infrastructure as part of routine maintenance and following all major rainfall events of greater than 1-in-10 year ARI. Sufficient freeboard in ponds to ensure that a high rainfall event does not result in over-topping.	Likelihood: Rare Consequence: Minor Risk: LOW	No compromise of pastoral use of downstream surface water bodies.	Water quality in North and South Mulga Dams shall be measured as soon as it is safe to do so following surface water flow, if there has been any release of mining solution into a flowing stream. This must show no compromise of pastoral use that it is attributable to mine operations. A mass balance calculation using estimated spill volume and chemical quality and estimated stream flow shall be undertaken to ascertain if any compromise is plausibly due to the mine. Applicable ANZECC/ARMCANZ stock water guidelines are: • salinity (EC) – 4,000 mg/L (6,000 uS/cm) • sulphate – 1,000 mg/L • uranium – 0.2 mg/L.	

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	HYDROGEOLOGY							
4.1	Drawdown and reduced flow in other pastoral bores that compromise their use, due to GAB water extraction for mining operations.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Hierarchy of water use to ensure GAB water not used where other sources are available and suitable. Low water use landscaping at camp. All GAB bores capped and metered with piped reticulation. Treated sewerage water and reverse osmosis reject water used where quality allows.	Increase employee awareness of the worth of the GAB as a water resource. Implement water saving equipment, procedures and programs.	Likelihood: Rare Consequence: Minor Risk: LOW	No compromise to other existing GAB users within the Beverley mine region.	GAB use not to exceed the allocated volume specified by license conditions which are issued according to the requirements of the approved Water Allocation Plan, Far North Prescribed Wells Area (DWLBC).	Volume of water progressively taken from GAB. Water pressures and pressure trends in GAB.

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
4.2	Contamination (including radiological) of the GAB aquifer arising from prolonged pressure drop in the GAB to less than the Namba aquifer and the creation of a pathway that compromises current and future possible use of the GAB. NOTE: Not a credible risk due to small GAB extraction rates, pressure differential between aquifers and the vertical and lateral seals between credible pathways.	Likelihood: Rare Consequence: Minor Overall Risk: LOW	GAB bores drilled away from mineralised and mined areas of the Namba formation and fully pressure cement grouted to surface. Well construction to meet well permit conditions. Refer to RWMP.	Maintain GAB pressures by recycle and re-use of various water streams and the implementation of a water treatment system to best manage ionic concentrations. Monitor GAB water use and pressures in Beverley. Adjust pressure in Namba aquifer at end of mining to restore pre-mining pressure gradient from the GAB towards the Namba aquifer.	Likelihood: Rare Consequence: Minor Overall Risk: LOW	No compromise to other existing Great Artesian Basin users within the Beverley mine region.	The pressure in the GAB at the extraction bores remains higher than the maximum pressure in Namba aquifer. GAB use not to exceed the allocated volume specified by license conditions which are issued according to the requirements of the approved Water Allocation Plan, Far North Prescribed Wells Area (DWLBC).	Volume of water progressively taken from GAB. Water pressures and pressure trends in GAB. Trend of EC ⁶ .
4.3	Contamination (including radiological) of the Willawortina aquifer by leakage caused by over-pressurisation of the Namba mining aquifer to the Willawortina aquifer that compromises its possible future pastoral use.	Likelihood: Rare Consequence: Minor Risk: LOW	Exploration holes cement grouted. Production and monitor wells cement grouted and integrity tested. Wells that do not pass integrity tests are cemented up and abandoned. Refer to RWMP.	Monitor Willawortina water levels and quality. Adjust pressure in Namba aquifer at end of mining to restore pre-mining pressure gradient from the Willawortina towards the Namba aquifer. Refer to RWMP.	Likelihood: Rare Consequence: Minor Risk: LOW	No compromise to pastoral use of the Willawortina aquifer.	Monitoring of ECL parameters and EC demonstrates that the category of pastoral use of the Willawortina aquifer does not change adversely in relation to ANZECC/ARMCANZ categories of water use, as a result of mining operations.	Water pressures in Namba injection and monitor wells. are less than the conservatively calculated aquitard fracture pressure of 760 kPa measured at the wellhead (see 6.5.7.1) Trends of water level and ECL parameters and EC.

⁶ Unusual EC measurements would trigger an investigation involving full major ion analysis, and potentially inspection of the wells and piping systems for damage.

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
4.4	Radionuclide contamination of the Willawortina Aquifer due to seepage from LLRW facilities (Refer to 4.3). NOTE: not a credible risk due to design of solid waste facilities, low rainfall and groundwater discharge, deep water table and presence of extensive clay in unsaturated zone.	Likelihood: Rare Consequence: Minor Risk: LOW	LLRW facilities are designed to relevant code located away from drainage lines, with clay base, plastic liner of sides and top, final clay capping above plastic and domed final profile to shed water. Refer to RWMP.	Appropriate characterisation of solid waste. Appropriate management of LLRW facilities whilst open. Refer to RWMP.	Likelihood: Rare Consequence: Minor Risk: LOW	No compromise to pastoral use of the Willawortina aquifer.	Appropriate records show LLRW facilities built to design. Groundwater quality monitoring (ECL parameters and EC) shows no compromise of Willawortina that could be attributed to the presence of the LLRW facilities.	Cell sump monitoring confirms that no water has entered the cell.
4.5	Contamination (including radiological) of the Namba aquifer units outside the Beverley Mine Lease arising from mining activities.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Monitor wells installed at appropriate depths, distances and spacing. Refer to RWMP.	Monitor Namba Formation water levels and quality. Adjust injection and extraction balances in mined areas to maintain control of mining or disposal solution. Adjust pressure in Namba aquifer at end of mining to restore pre-mining pressure gradient or a gradient towards mined area. Refer to RWMP.	Likelihood: Rare Consequence: Minor Risk: LOW	No compromise of potential pastoral use (should it meet pastoral water quality standards) of the Namba aquifer outside the Beverley mining lease.	No migration of mining and disposal solutions outside the ML as demonstrated by ECL monitoring and response (see Section 6.5.8.3 which includes contingency measures).	ECL monitoring trends

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	FAUNA							
5.1	Reduction in native vertebrate species density and diversity caused by wellfield development, access road construction and operations.	Likelihood: Possible Consequence: Minor Risk: MODERATE	Minimise perennial vegetation clearing by design: - Fencing patches of vegetation and soaks to protect seed stock and habitat. - Run pipeline on surface. - Wellfield and projects planning.	Enforcement of Environmental Clearance Permit system. Enforce speed limits within Mining Lease. Rapid backfilling and rehabilitation of mud pits. Presence of drilling crews (discouraging fauna near pits and operations). Rescue of trapped fauna. Backfilling of exploration and delineation drill holes. Placing stockpiled vegetation as habitat. Recreational hunting prohibited within the lease area.	Likelihood: Unlikely Consequence: Minor Risk: LOW	No net adverse impacts from the site operations on native fauna abundance or diversity in the lease area and in adjacent areas ⁷ .	Results of monitoring program show no reduction of native vertebrate density and diversity compared with local area background as per fauna monitoring (see Section 6.6).	Trends of the monitoring program.

⁷ Control sites are chosen by qualified and experienced specialists (see text)

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
5.2	Reduction in native vertebrate species density and diversity resulting from an increase in feral animals caused by creation of food sources, modified habitat and waste management operations.	Likelihood: Unlikely Consequence: Minor Risk: LOW	Fencing of putrescible waste disposal areas to reduce access by larger ground fauna	Covering of putrescible waste. Increase personnel awareness via inductions and notices.	Likelihood: Rare Consequence: Minor Risk: LOW	No net adverse impacts from the site operations on native fauna abundance or diversity in the lease area and in adjacent areas ⁸ .	Results of monitoring program show no reduction of native vertebrate density and diversity compared with local area background as per fauna monitoring (see Section 6.6) Results of monitoring program show no increase in feral vertebrates, compared with local area background, based on assessment by the appropriately qualified and experienced specialists engaged to undertake and assess the monitoring program.	Trends of the monitoring program.

⁸ Control sites are chosen by qualified and experienced specialists (see text)

ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
5.3	Reduction in adjacent pastoralist viability due to increase in feral animals due to mining operations.	Likelihood: Unlikely Consequence: Minor Risk: LOW		Prohibition on pets within the lease area. Trap and destroy feral species. Recreational hunting prohibited within the lease area.	Likelihood: Rare Consequence: Minor Risk: LOW	No introduction of new weeds, plant pathogens or pests (including feral animals), nor increase in abundance of feral animals in the lease area compared to adjoining pastoral areas. ⁹	All complaints from neighbours regarding feral animal control are investigated and are demonstrated to be not due to mining operations.	
AIR QUALITY								
6.1	Radon release from processing area and water management ponds (and other sources) increasing radiation doses to the environment or the public.	Likelihood: Rare Consequence: Minor Risk: LOW	Tank ventilation at appropriate height. Refer RWMP (RMP)	Radon and Radon progeny monitoring and review. Refer RWMP (RMP).	Likelihood: Rare Consequence: Minor Risk: LOW	No adverse impacts to workers, public or the environment due to radon release, uranium bearing-dust, nor radiological aspects of seepages and spills.	Estimated radiation doses to the public (and workers) within applicable limits as defined under the RPC Act.	Trends from monitoring of radon decay products and uranium dust in the processing plant, ponds and accommodation camp areas remain below the investigation levels

⁹ Whist this outcome includes vegetation it is included here as the Mining Lease condition lists feral animals with weeds

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
6.2	Uranium-bearing dust released from drier and packaging area increasing radiation doses to workers or the public.	Likelihood: Rare Consequence: Moderate Risk: MODERATE	Dust extraction and filtration system on drier and packaging enclosure. Refer RWMP (RMP).	Good maintenance Air sampling conducted in the drier and packing areas. Sampling of exhaust stack particles. Refer RWMP (RMP).	Likelihood: Rare Consequence: Minor Risk: LOW	No adverse impacts to workers, public or the environment due to radon release, uranium bearing-dust, nor radiological aspects of seepages and spills.	Estimated radiation doses to the public (and workers) within applicable limits as defined under the RPC Act.	Trends from monitoring of radon decay products and uranium dust in the processing plant, ponds and accommodation camp areas remain below the investigation levels
	HERITAGE							
7.1	Impacts on Aboriginal heritage as a result of mine activity.	Likelihood: Rare Consequence: Major Risk: HIGH		Maintain and improve the use of Aboriginal Heritage Clearance surveys. Protection of heritage sites in accordance with State and Commonwealth legislation (there are currently no listed heritage sites within the ML). Check flagged areas for disturbance.	Likelihood: Rare Consequence: Moderate Risk: MODERATE	No disturbance to Aboriginal artefacts or sites of significance unless prior approval under the relevant legislation is obtained. Commitments to Traditional Owners as set out in agreements are met.	Documented Aboriginal Heritage Clearance surveys of all operational areas. Audits show flagged areas are not disturbed. Commitments to Traditional Owners reviewed and discussed at the Beverley Advisory Committee to the satisfaction of members (as the agreement is confidential the measurement criterion will be the absence of disputes requiring legal action).	Near-miss incident reports relating to potential disturbance of flagged areas.
	RADIOLOGICAL ASPECTS							
	Soil	See Potential Impact Event ID 1.1						
	Vegetation	Protection of soil will promote vegetation						

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ID	Potential Impact Event	Inherent Risk Level	Design Control Measure(s)	Operational Management Measure(s)	Residual Risk Level	Outcome(s)	Outcome Measurement Criteria	Leading Indicator Criteria
	Surface Water	See Potential Impact Event ID 3.1						
	Hydrogeology	See Potential Impact Events ID 4.2, 4.3, 4.4, 4.5						
	Fauna	Protection of vegetation (via soil) and surface water will also protect fauna						
	Air Quality	See Potential Impact Events ID 6.1, 6.2						
	Heritage	Not applicable						

APPENDIX B: Annual Vegetation Monitoring Report

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BEVERLEY URANIUM MINE
VEGETATION MONITORING OBSERVATIONS
SEPTEMBER 2009

Prepared for

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1 SUMMARY

Vegetation monitoring observations at the Beverley Uranium Mine were undertaken in the spring of 2009, from 1-9 September. This was an interval of 12 months since the previous monitoring. Monitoring was carried out on behalf of Heathgate Resources by Dr Frank Badman of Badman Environmental, with assistance from Evan Badman.

Monitoring has been designed to fulfil the requirements formalised within the Beverley MARP and the 2009 monitoring followed the same format as in previous years. The timing of the monitoring is now intended to record the winter-growth suite of plants and to optimise the detection of alien plant species. This year, for the second time, data were collected from new 5m x 2m quadrats at the 25 sites set up during the 2005 baseline survey of additional lease areas, and from an additional seven control sites, all at distances greater than five kilometres from known ore reserves, that were set up and monitored in 2008.

The main findings of the 2009 survey were that the Mitchell Grass grasslands that were once dominant in the area continue to be in very poor condition or absent. Most other perennial species have declined in cover and fewer species were recorded than in previous surveys. These changes were recorded in all land-use areas, and in all landforms. There was some growth of ephemeral species during the year, but this had mostly hayed off prior to the survey.

The improved condition of rehabilitated sites in the northern wellfield has now been reversed in most cases; while sites in the southern wellfield are yet to recover from the initial disturbance.

Decreases in species richness are no longer statistically significant for any areas, but there was an overall significant increase in species richness at pastoral sites. The decrease in cover values is now significant for all sites except sites in the Mine Lease outside the development areas. Decreases in perennial cover values are non-significant for all areas except pastoral sites.

No erosion is evident from photo points for the period September 2008 to September 2009. The most significant impacts recorded are those associated with nearby wellfield development and ancillary activities.

Dust does not appear to be affecting vegetation to any great extent away from the area of intense wellfield development. Any affect it may be having in the development areas cannot be separated from other more direct impacts and lack of rainfall.

No threatened species were identified from the Beverley Mine area during the year.

No additional alien species were recorded during the September 2009 survey. The recorded incidence of alien plants at the Beverley mine site is still about the same as at other similar areas in northern South Australia. Only one proclaimed plant species was recorded during the 2009 survey; this was *Tribulus terrestris* which was found to be common on the mine lease and in all surrounding areas.

One new monitoring site, BE32, was set up in Paralana Creek between RL19 and RL20 at the southern end of the mine lease area.

2 MONITORING BACKGROUND AND OBJECTIVES

2.1 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The Beverley vegetation monitoring is a requirement of the Beverley MARP (Beverley Uranium Mine 2008). The objectives of the MARP are to:

- Minimise reduction in regional native vegetation species density and diversity due to mining operations
- Minimise loss of native vegetation (habitat) due to clearance for mining operations
- Minimise introduction of new or increases in abundance of existing weeds
- Minimise loss of native vegetation (habitat) due to mining-related fires.

Strategies to control and manage the vegetation include:

- Design Measures
 - Minimising perennial vegetation clearing by design (wellfield and projects planning)
 - Fencing patches of vegetation and soaks to protect seed stock and habitat
 - Run pipelines on the surface
 - Wellfield projects planning
 - „Shake down’ (de-dust) area prior to main entrance to ML for incoming traffic to drop seeds
 - Fire fighting equipment
 - Road/tracks act as firebreaks
 - Design control measures to be implemented should fuel loads become significant
- Management Measures (relevant to annual vegetation monitoring)
 - Annual flora survey to identify trends
 - Weed control
 - Progressive and final rehabilitation
 - Any increase or new occurrence of weed species is not significantly different to adjoining pastoral areas
 - Control sites are planned approximately 5 km away from planned disturbance areas

Other requirements of the MARP are to

- Survey 5 m x 2 m vegetation quadrats
- Survey 4 x 1 ha quadrats for weed abundance

Controlled photographs taken from set points, usually with an associated plant quadrat, provide the basic monitoring tool. The system derives originally from the Koonamore Vegetation Reserve and was subsequently modified by T.J. Fatchen and A.C. Robinson within the SA NPWS in the 1970s. It is in general use within the SA Parks System and in western New South Wales and has been applied on a large scale in the Olympic Dam development (Fatchen Environmental 2001).

The majority of photopoints have an associated 5m x 2m quadrat within the foreground of at least one of the picture fields. This quadrat, intended to be read yearly, provides local “ground truth” and a source of hard data additional to the information content of the photo itself. Plant species within the quadrat are identified and their cover scored, permitting a detailed local tracking of species richness, overall cover, and cover of both individual species and any relevant groupings (such as perennial or ephemeral species). Photographs are taken four times each year by Heathgate Resources environmental staff. Changes noticeable from the photographs are reported here, but the actual photographs are retained in the site Environmental Office.

Photopoints are situated in areas currently under development, in areas unlikely to be developed and on pastoral country outside the mine lease fence (Figure 1). In addition, 25 new photopoints (Figure 2) that were set up within or adjacent to one hectare quadrats established during the additional leases baseline survey in 2005 (Badman 2006b) were sampled for the second time in September 2008. The 2007 and subsequent photographs from the additional leases are not directly comparable with the 2005 baseline survey photographs because in all cases they are taken from a different position. Seven new control sites were set up and sampled for the first time in 2008. These are all more than five kilometres from any known part of the ore body.

All photopoint and quadrat locations are given in Table 1 and their relation to existing development is summarised in Table 2. A summary of photographic information from the Beverley Mine Lease and the Mine Lease Extension is given in Table 3. Additional short-term photopoints have been used occasionally by Heathgate Resources, but these are not included in the present monitoring analysis.

The basic monitoring technique is applied not only for documentation of the vegetation *per se*, but also for following and recording incidental impacts, potential dust or erosion hazards and rehabilitation.

The Beverley EIS (Heathgate Resources 1998) proposed a simple vegetation monitoring methodology for the Beverley Uranium Mine based on utilisation of photopoints without quadrats. In response to regulators' requirements, quadrats to provide "hard" data were added to the monitoring system, with the first detailed quadrat records taken in November-December 1998. The photographic monitoring commenced a year earlier. This has been formalised in the EMMP and a further component added to provide one 100m x 100m quadrat on a Mitchell Grass plain (at BU15) as a further reference.

Information gathered from the monitoring system provides feedback to management on the objectives of the EMMP and allows remedial action to be undertaken as required.

2.2 RARE, THREATENED OR ENDANGERED SPECIES

A specific watch is kept for species listed in relevant legislation as rare, threatened or endangered. Three rare or vulnerable species have been reported as present on or near the site, with the identity of only one of these being confirmed by a voucher specimen lodged in the State Herbarium of South Australia.

Swainsona oligophylla, which is listed as rare in South Australia (Lang and Kraehenbuehl 2008), was collected at the one hectare quadrat at BU15 in September 2005 (FJB 11752) and also near the control site at monitoring site 7 along the Epic Gas Pipeline corridor (FJB 11767) in the same year, but it was not identified by botanists at the State Herbarium of South Australia in time for inclusion in the 2005 Annual Report (Badman 2006a). This plant was listed as being uncommon at both sites at this time, but it has not been recorded during subsequent monitoring events. The BU15 site is well away from areas proposed for any development and the area near the Epic Pipeline will not be disturbed by any actions of Heathgate Resources.

Frankenia subteres is listed as rare in South Australia (Lang and Kraehenbuehl 2008). Occurrences noted in the baseline were outside the development area, but the species has since been reported within the development area (Fatchen Environmental 2002). This is discussed further in Section 5 of this report.

Swainsona murrayana, which is listed as vulnerable in South Australia (Lang and Kraehenbuehl 2008), was reported in the baseline survey. The area within the retention leases where this species was (vegetatively) scored is not proposed for development. The presence and identity of the species cannot be confirmed and its listing appears to have been a field identification error. However, in the majority of subsequent years, there has not since been an appropriate winter rain or late spring observation, combined with stock exclusion and low kangaroo grazing pressure, all of which must apply for the species to be detectable and identifiable. There is no official record of this species from anywhere near the Beverley mine site, with the closest herbarium specimens being from the vicinity of the Boolcoommatta Homestead (AVH 2010).

2.3 ALIEN INTRODUCTIONS

Additional to quadrat information, an opportunistic watch is kept for pest plant appearances on sites associated with construction or operation. Particular attention is paid to wet areas around the camps, process plant, Four Mile Bore and standpipes or tanks for truck filling.

In 2009, for the first time and at the request of the regulators, three one hectare quadrats in the additional lease areas were closely inspected for alien species.

3 METHODS

3.1 TIMING AND SETTING.

Vegetation monitoring at Beverley was undertaken from 26 August to 7 September 2009, an interval of 12 months from the previous vegetation monitoring. Monitoring was carried out on behalf of Heathgate Resources by Dr Frank Badman of Badman Environmental, with assistance from Evan Badman. This is the eighth year in which monitoring has been carried out in late spring or early summer. The shift from early autumn to late spring arose from a faunal monitoring recommendation, to provide better opportunities for tracking faunal species (Fatchen Environmental 2002), rather than from a requirement of the vegetation monitoring. In terms of the vegetation, the monitoring now records the winter-growth suite of ephemeral and biennial species rather than the summer-growth suite which includes the once dominant perennial Mitchell Grass.

The period since the October-November 2002 monitoring included useful rainfall in December 2002 (33.5mm) late February 2003 (39.5mm), mid April 2003 (11.5mm) and July-August 2003 (34.5mm). The summer rainfall was sufficient to promote some growth in the Mitchell Grass, but this was largely removed by grazing prior to the December 2003 monitoring. Some ephemeral species grew during the year and there was an ongoing increase in the cover of biennial species, particularly chenopods.

The total rainfall for 2004 was 101.75 mm and for the whole of 2005 was 99.5 mm, with 32.5 mm of the 2005 total falling after the September 2005 monitoring. Total rainfall between the 2004 and 2005 monitoring events was 73.5 mm, well below the mean for this area. Only 106 mm of rain was recorded at Beverley in the 12 months prior to the 2006 survey. The most effective rainfall events during this period were 32.4 mm in both April and July 2006. Rainfall in the 12 months preceding the 2007 survey was only 70 mm, of which 44.6 mm fell during May. Only 0.4 mm fell in the three months following this rainfall event prior to the 2007 survey.

Rainfall in the 12 months preceding the 2008 survey was even lower than in 2007, with only 67.2 mm recorded. This was made up of 12 mm over 48 hours in October 2007, 22.4 mm from 23 October to 3 November, 6.4 mm on 21-22 December, 5.2 mm during the first week of February and 23.8 mm from 5-12 June (Beverley Mine rainfall records).

Rainfall for the 12 months prior to the 2009 survey was 103.3 mm. This gives a mean annual rainfall for the last eight years of under 100 mm (Beverley rainfall records).

The closest station for which long term rainfall records are available is Wooltana, which has a mean annual rainfall of 192 mm (Heathgate Resources 1998). Rainfall for the period between the 2004 and 2009 vegetation monitoring events lies within the lowest decile for this area (Heathgate Resources 1998).

3.2 DATA COLLECTION AND ANALYSIS

Data collection and analytical techniques are firstly intended to detect disturbance, whether natural or a consequence of development. Photographic capture of impacts or alterations is the primary technique. Secondly, the photographs themselves allow the detection of changes in gross plant community composition and structure. The photopoint quadrats allow a more detailed localised following of plant community composition, species richness and cover of individual species, particularly increase or reduction of the perennial species which contribute to landscape stability. Means for doing so include:

- Qualitative data from visual information from photographs. These include:
 - presence/absence of disturbance such as tyre marks, hoof prints, and construction activities;
 - increases or decreases in bare ground;
 - increases or decreases in erosional processes such as gullying, sedimentation, and soil drift;
 - mortality, recruitment and changes in health of perennial plants, particularly larger shrubs and tree species not usually present in quadrats.
- Quantitative data from visual information in photographs.
- Quantitative data on plant community composition and cover from quadrat information.

Quadrat layout is shown in Figure 3. A tape is laid out from the photopoint peg to the sighter peg and two other tapes are laid out one metre on either side of the central tape and parallel to it. The quadrat begins at a point five metres from the photopoint peg and extends for five metres to the sighter peg. Cells are laid out in two rows, one on either side of the central tape. Cover values for each species present are estimated for the ten 1m x 1m cells, in the order shown in Figure 3, and recorded on an appropriate data sheet. No other calculations are carried out in the field.

Raw field data are transferred to a computer spreadsheet and calculations on species richness and cover values for each site and for each vegetation class are then carried out (Appendix A).

Up until 2002, data analysis was restricted to individual sites, with no attempt made to examine the data over time because of the short period over which data had been collected (Fatchen Environmental 2002). In 2003, for the first time, and in all subsequent years, comparisons have been made between the data for the current and previous years and this is continued in this report (Appendix B). These data have also been summarised for the three different impact areas: mine site development areas, mine site areas away from all development and pastoral areas.

Since 2007 data have been included from sites that were set up at or adjacent to the one hectare quadrats established as part of the additional leases baseline

survey (Badman 2006b). These data are summarised in Table 16 (species richness) and Table 17 (cover). Sites have been grouped under their landform type: major creeks (Four Mile Creek), tablelands and minor watercourses. They cannot be grouped under different land uses because no mining has yet occurred in these areas. A comparison with the 2007 and 2008 data is made in this report, but this is only possible for the three years in which data have been collected.

Site photography continues to be carried out by Heathgate Resources environmental staff and does not form part of this survey, although interpretation of the photographs is reported here (Table 3).

Graphing of biomass trends has now been discontinued. The somewhat subjective results that were presented in earlier years are now better represented by quantitative results presented in graph form in Appendix B.

Floristic data for the formal 100m x 100m quadrat established at BU15 uses the standard Biological Survey of South Australia recording methods (Heard and Channon 1997). This one hectare quadrat was first sampled in 2001 and its corners were pegged in December 2003 to ensure that the same area is sampled each year. All species present are listed and given an abundance score and the life form (growth stage) of each species is also recorded. Annual species richness trends for all species and for perennials are shown in Figure 11. Life form codes and abundance scores are shown in Appendix C.

4 RESULTS

4.1 PHOTOGRAPHIC ANALYSIS

4.1.1 Summaries

Observations on photopoint view fields, land use, and condition are summarised in Table 3 with notes on impacts or other points of interest at individual times. The main changes have occurred at sites that were formerly dominated by Mitchell Grass: this species has now been largely replaced by chenopod forbs or by bare ground. No significant growth of this species has been recorded since 2001 (Figure 4). Where still present, it is represented only by rhizomes and occasionally by butts. Limited vegetative material was observed during the 2009 survey, the result of a single heavy rainfall event at the end of 2008. Most of the new growth had been eaten by kangaroos prior to the August-September 2009 survey. No evidence of the presence of any other large herbivore was seen during the 2009 survey.

4.1.2 Overt impacts

Other than grazing and effects associated with seasonal conditions, there are no off-target impacts evident from photopoints for the period September 2008 to September 2009. Impacts recorded are those associated with exploration drilling, wellfield development and ancillary activities.

Wellfield impacts are still evident within the photographic field of view, but generally not within quadrats, at some photopoints in the northern, central and southern wellfields. The greatest changes in the wellfield areas are in species richness and cover and these are discussed in the following section. Unlike the northern wellfield, development of the southern wellfield has largely been designed to avoid the vegetation monitoring quadrats. Some quadrats have been temporarily fenced to exclude vehicle access. The start of rehabilitation at most heavily disturbed sites in the northern wellfield has now been reversed by the dry seasonal conditions. Most young plants have now died. The best regrowth of Mitchell Grass at the end of 2008 occurred in gilgais, where additional water had collected. Impacts are described in more detail in Table 3.

No noticeable growth of Mitchell Grass was evident in any of the site photographs taken during the year and this species no longer makes a significant contribution to the vegetation as it did in 1998 (Figure 4).

A major summer rainfall event and follow-up rains, as opposed to the single moderate rainfall event of late 2008, will be necessary for Mitchell Grass to return to its baseline level (Heathgate Resources 1998) and for this to be sustained. Even if this does occur there is no guarantee that vegetation will return to its 1997 composition. The “State and Transition” model proposed by Westoby *et al.* (1989) suggests that when there are major changes in vegetation composition caused by dramatic events such as drought, grazing or fire, the vegetation does not necessarily return to its original condition. A new and different stable state may be attained depending on the set of circumstances that promote the recovery. The recent domination by short-lived chenopod forbs may in fact represent a new “stable state”. Many of the Mitchell Grass butts that were present and still viable as late as 2004 are now

completely dead and in such areas regeneration of this species would have to occur from seed.

In addition, evidence on the death of perennial grasses in other parts of Australia provided by Hacker *et al.* (2006) suggests that many Mitchell Grass plants at Beverley have already passed the point of no return and may no longer have the ability to re-sprout from the remaining butts. In this case, regrowth will have to come from seed and the process will be much slower.

No evidence was seen of any fire occurring on the mine lease or in surrounding pastoral country. In fact it would have been very difficult to find enough vegetation to sustain a fire in these areas.

4.1.3 Tree and shrub deaths

No deaths of trees or shrubs were recorded in September 2009 that resulted from wellfield development or operations. There was a considerable loss of leaf material on many trees and tall shrubs (Table 3), but none of this can be attributed to any operational activities.

4.2 QUADRAT INFORMATION

4.2.1 Photopoint quadrats

Species richness and total cover from the 5m x 2m quadrats, for all plant species and for perennials only, are summarised in Table 4. Time-series graphs for each site are presented in Appendix B and are summarised for each impact area in Figures 6-10. Comparisons between the different impact areas are presented in Figures 12-15. Summaries of species richness and cover for sites in the new development area are shown in Figures 16 and 17.

Total species richness and cover were lower in all areas in 2009 than in 2008. This is discussed in the following section.

4.2.2 Comparisons between different impact areas

Species richness and cover values for all species and for perennials only are summarised in Figures 6-11 and Table 4.

These figures show similar trends (decreases) between the different impact areas for total species richness and for perennial species richness. These changes are quite small and are not statistically significant (Table 4).

In mine development areas, total species richness showed a small decrease from the previous year (Figure 6). The changes at individual sites were quite varied (Table 4) but the overlap of error bars in figure 12 suggests that these differences were not significant; the number of species involved was very low. Total cover here rose by 39%, but perennial cover fell by 38%. The decrease in perennial cover was statistically significant (Table 4).

There was a 4% increase in total species richness for areas on the mine lease that are distant from all development (Table 4), while the species richness for perennial species here decreased by 25%. There was a decrease in cover values for both total cover (20%) and for perennial species (43%). Again, these decreases are not significant (Table 4), probably because of the very low number of species involved.

Total species richness at pastoral sites increased by 51% but perennial species richness fell by 13%. Total cover at these sites increased by 81%, while perennial cover fell by 47%; the increase in total cover was statistically significant (Table 4).

The statistical significance of the changes in species richness and cover between the 2008 and 2009 values is shown in Table 4. The most significant changes are for total species richness at pastoral sites, which is a reversal of the situation reported in 2008, and a decrease in perennial cover at sites within the mine lease.

The lack of significance in most categories and in most groups (Table 4) is probably due to the very small numbers recorded for both species richness and cover at most sites. Some ephemeral species grew during the year, which increased the values for total cover at near mine and pastoral sites but not at the distant mine sites. These rainfall events apparently did not have the same effect on perennial species.

Decreases in total cover values are significant only at mine sites that are distant from development (Table 4).

Because several of the mine development area sites have had all vegetation removed in the past, the trends shown in Figures 6-11 give a better indication of what is happening to vegetation in the different impact areas than the numbers given above. A small change when there are few species or little cover present results in a large percentage change, but causes little change to the trend shown in a graph.

The once-dominant Mitchell Grass is now at its lowest recorded level (Figure 4). Multiple major rainfall events during summer will be required before there is any chance of the Mitchell Grass returning to its former dominance. At least 150 mm of rain during summer, together with a similar follow-up rainfall event, will probably be required to promote recovery of this species (see Section 4.1.2 for further discussion on this point).

Grazing pressure from kangaroos on the mine lease and from cattle and kangaroos on pastoral country continue to be more or less equal, although there was less grazing impact from cattle during the past year than in previous years. Cattle numbers on Wooltana Station were the lowest recorded since the start of mining operations at Beverley (Wooltana Station Stock Records).

Badman (2002) demonstrated that total grazing pressure on a fenced mine lease where domestic stock have been excluded can be equivalent to or greater than that on surrounding pastoral country, particularly when kangaroos are not culled on a fenced mine lease. This appears to be the case at Beverley. Kangaroos still graze the mine lease and because of a lack of competition with cattle, and the establishment of watering points for them, may now prefer to graze there rather than on adjacent pastoral country. Rabbits may also be a contributing factor, but numbers are likely to be similar on the mine lease to those in similar habitats on surrounding pastoral country. In all cases, it is total grazing pressure that is important rather than grazing by domestic stock, or any single herbivore.

4.2.3 100m square quadrat at BU15

Floristic data for the formal 100m x 100m quadrat established at BU15, using the standard Biological Survey of South Australia recording methods (Heard and Channon 1997), are given in Appendix C. This one hectare quadrat was originally set up as a control area on Mitchell Grass uplands distant from all development areas and protected from domestic grazing. Its establishment was a regulatory requirement.

Species richness for this quadrat is given in Figure 11. This chart shows similar trends to those for undeveloped mine lease areas in general (Figure 6), although Figure 11 is likely to give a better indication of the trends over time because the data have been collected from a much larger area than that used to prepare Figure 6. Between the quadrat's establishment in March 2001 and its second reading in October 2002, species richness and cover-abundance effectively halved as a response to drought and to a lesser extent heavy kangaroo grazing (Fatchen Environmental 2002). This trend was reversed during 2003, with total species richness increasing by 188% during the year and perennial species richness increasing by 28%. In 2004, total species richness fell by 35% and perennial species richness by 11%. In 2005, total species richness rose by 59%, while perennial species richness remained the same. In 2006, total species richness fell by 26% while perennial species richness rose by 12%. Total species richness rose by 35% in 2007, while perennial species richness rose by 33%. In 2008, total species richness fell by 51% while perennial species richness fell by 25%, but in 2009 there was a small (two species or 25%) increase in perennial species richness while total species richness remained the same.

Perennial species richness remained in the range 7-9 species throughout the period 2001-2006, but increased to 12 in 2007, returned to 8 in 2008 and increased to 10 in 2009.

It is difficult to get meaningful cover results from the one hectare quadrat data. This can be done by using mid-point values for the scores recorded in Appendix C, but because the main species only just attained a cover score of "2" (5-25%) in the period 2001-2004, the mid-point value (15%) would have overstated the true value by 8-9%. Data from the one hectare quadrat demonstrate the same trend that is depicted more accurately by the data from the 5m x 2m quadrats. However, the one hectare data do give a better indication of the local floristic composition and species richness over time than can be obtained from the small quadrats.

4.2.4 Comparisons between different land use areas

Figures 12-15 show the comparisons between total and perennial species richness and cover at all Beverley Mine Lease sites from 1998 to 2009. The overlap of error bars on these graphs, set at a 5% confidence level, suggest that there is no significant difference in mean species richness between the different areas (Figure 12).

Differences between perennial species richness in the three areas may have been more significant in the last three years than in previous years. Overall, the error bars suggest that there is no significant difference between perennial cover on the mine lease development areas and at pastoral sites, with slightly

better values recorded from mine sites distant from development (Figure 13). The latter point is to be expected because these sites are set up away from all development and are not grazed by domestic livestock.

Average cover values for all species from 1998-2009 are almost identical for the mine development areas and for the pastoral sites, with a significantly higher mean value for mine lease sites away from development (Figure 14). This trend appears to have been consistent for most years since 2001.

Figure 15 also shows the same trends for perennial species cover that are apparent for total species cover.

4.2.5 Quadrats in the Additional Leases

Because no development activities have yet been undertaken at any of these sites, they can be compared only on the basis of land form and not on land use as is the case with the Beverley sites.

A summary of species richness and cover values for sites in the additional lease areas are shown in Figures 16 and 17. These show that both total and perennial species richness remains highest at the minor watercourse sites, while those in major creeks have the lowest. Total cover was again highest on the plains, but perennial cover was highest in the major creeks. Mean perennial cover was lowest at minor watercourse sites.

Trends in both cover and species richness at these sites are similar to those at mine sites distant from development and to pastoral sites; although the overlap of error bars (Figures 16, 17) suggests that none of these sites show a statistically significant change from the previous year.

4.2.6 Quadrats at new distant control sites

Six new control sites were set up in 2008. These sites fill a requirement of the Regulators to have control sites that are at least five kilometres from any ore body. Their locations are shown in Figure 2 and Table 1. A summary of the mean species richness values for these sites is shown in Figure 18 and for cover values in Figure 19.

It is difficult to make direct comparisons between these sites and the older monitoring sites because the original sites are grouped on land use and the new controls are presently grouped on land form. However, because they are all distant control sites they do fit into the pastoral sites category.

The trends shown for both cover and species richness values in Figures 18 and 19 are similar to those shown for the new development areas (the “BE” monitoring sites). The main difference is that species richness values are slightly higher at the new control sites in 2009 than in 2008, while the opposite is true for the new development areas.

Species richness shown in Figure 18 shows an identical trend to that shown for all vegetation types in Figure 16.

4.2.7 New Quadrat in Southern Lease Area

A new one hectare quadrat and a 5m x 2m quadrat, numbered BE32, were set up and read inside the southern lease area between RL19 and RL20 in

September 2009. This was the only remaining lease area without any vegetation monitoring quadrats. Data from the small quadrat is included in Appendix A, and for the large quadrat in Appendix D.

This quadrat is sited across Paralana Creek to the west of the main access road to the mine. It is entirely located on sandy creek soils, with the photopoint peg and the small quadrat placed on the northern side of the creek.

Conditions were very dry at the time of the survey and only two species were found in the small quadrat. Vegetation of the one hectare quadrat was dominated by the large tree *Eucalyptus camaldulensis* and the tall shrub *Melaleuca glomerata*. *Acacia ligulata* and *Acacia victoriae* were also present in small numbers. Ground cover was quite sparse (Appendix D).

5 THREATENED SPECIES

No threatened species were recorded during the 2009 survey.

Swainsona oligophylla is the only threatened species whose presence on the mine lease has been confirmed by means of a voucher specimen (FJB 11752) lodged with the State Herbarium of South Australia. This species was collected at the One Hectare quadrat at BU15 during the September 2005 survey, but its identity was not confirmed in time for it to be included in the 2005 Annual Report (Badman 2006a). It was also recorded along the Epic Gas Pipeline in the same year (see Section 2.2). This species is listed as rare in South Australia (Lang and Kraehenbuehl 2008) and was recorded as being uncommon at this site in September 2005. BU15 is well away from areas proposed for any development and the section of the gas pipeline where this species was recorded is on pastoral country outside the mine lease. There are numerous records of this species from the north and north-east parts of the state, with many from the Innamincka area, but no others from around Beverley (AVH 2010). There is also a record from the Epic gas pipeline corridor near Erudina, well south of Beverley. From the 2005 records, it appears that this species is sparsely present in the Beverley area following good winter rainfall.

Recent work by Dr Molly Whalen of Flinders University on the genus *Frankenia* raises some doubt as to whether *Frankenia subteres* actually does occur in the Beverley area. The occurrence of this species here is based on a single collection made by W.D. Williams during the baseline survey (Williams 1979). This collection was seen in the State Herbarium of South Australia during early 2005, when it was still labelled as *Frankenia subteres*, but could not be located in January 2006. The Williams record is no longer shown on the Plant Distribution Mapper section of the South Australian node of Australia's Virtual Herbarium (AVH 2010) and there are currently no records of this species in the immediate Beverley area.

Dr Whalen has been working on the genus *Frankenia* for many years but the work is still unfinished and many collections that have been redetermined have yet to be labelled. Many collections of *Frankenia* were temporarily renamed as "*Frankenia* sp." during the latter part of 2005 when the identity of several *Frankenia* collections was re-examined in order to complete Species Profiles and Threats (SPRAT) sheets for two threatened *Frankenia* species (DEH 2005) and it is likely that the Williams collection was one of them. All collections of *Frankenia* made in the Beverley area since 2003 have been of the common and ubiquitous *Frankenia serpyllifolia*. The true identity of the Williams collection will continue to be investigated and will be reported as soon as it is known.

A watch continues to be kept for *Swainsona murrayana*, but so far without any success. This increases the likelihood that a field identification error was made in the 1978 baseline survey (Fatchen Environmental 2002). *Swainsona murrayana* is known to occur in the botanical region which includes the Beverley Mine (Barker *et al.* 2005), but the closest records appear to be well to the south of Beverley. AVH (2010) shows records from near the Boolcoomata Homestead.

6 ALIEN INTRODUCTIONS

6.1 GENERAL COMMENTS

Alien species were recorded at 18 of the 28 (64%) BU monitoring sites and at 16 of the 25 (64%) BE monitoring sites during the 2009 survey. Records were from sites in all land use categories and from all habitat types. Only two species were involved. *Brassica tournefortii* (Wild Turnip) was recorded at a single site (BE03), while all other records were of the Proclaimed *Tribulus terrestris*, which was recorded in all habitats and in all land-use areas.

Three one hectare quadrats in the additional lease areas were also closely examined for alien species (weeds). These additional quadrats are located at BE05, BE09, BE16 and BE32. This provided no information that was not already provided by the 5m x 2m quadrats at these sites. *Tribulus terrestris* was the only species recorded at the first three of these sites. It was recorded at a cover score of “1” at the first two sites and “T” at the third site¹. *Tribulus terrestris* and *Brassica tournefortii* were recorded at BE32, both at a cover score of “T”.

A dedicated weed survey was carried out at the Beverley mine site for the first time in September 2004 and this has been repeated in all subsequent years. Areas where weed species are considered most likely to become established are searched specifically for such species. These included the camps and process plant areas, the Four Mile Bore, ponds, drains, water truck filling stations and other areas of open water or water spillage. The formal vegetation monitoring sites are sampled for weeds as part of the routing monitoring programme and any weed species noticed while driving round the site are also recorded.

The most commonly found weed species in previous years, *Solanum nigrum* (Black Nightshade) was not recorded in 2009. This species has been the subject of an intensive control campaign carried out by Beverley Uranium Mine environmental staff. Control of some water outflows from the main camp and from process plant area since 2004 has also assisted in this work.

A single plant of *Nicotiana glauca* (Tree Tobacco) was recorded during 2007 at a pond within the process plant area. This plant was removed prior to the 2008 survey and there was no re-occurrence in that year. However, another single plant was recorded in the plant car park in 2009 and subsequently removed. This species is common in the Flinders Ranges and in the general area.

¹ The difficulty of determining a precise cover value for any species in a one hectare quadrat has been previously discussed for the quadrat at BU15 (Badman 2003). These quadrats are scored using the methodology of the DEH Biological Survey (Heard and Channon 1997) which uses a cover score for each species rather than an absolute cover value. Obtaining an absolute cover value would require splitting the one hectare quadrat into numerous small quadrats and probably could not be completed in one day. It would also entail the trampling of a large amount of vegetation in the quadrat. The scores used here are: N – Not many (1-10 plants per hectare and less than 5% cover); T – Sparsely or very sparsely present; cover very small (< 5%); and 1 – Plentiful, but of small cover (< 5%). The difficulty of obtaining a precise cover measurement when using this system is the reason why the small quadrats are used for the main monitoring at Beverley.

Four alien species, *Spergularia marina* (Salt Sand-spurrey), *Cynodon dactylon* (Couch), *Cucumis myriocarpus* (Paddy Melon) and *Chenopodium murale* (Nettle-leaf Goosefoot) were recorded at the Four Mile Bore. The area of the wetland here is much less than in some previous years and this has led to a reduction in the number of alien species found there. The first two of these alien species at the Four Mile Bore wetland have a cover score of “1”, *Chenopodium murale* a score of “T” and *Cucumis myriocarpus* a score of “N” per hectare.

In previous years, more alien species have been present along the Four Mile Creek than in any other habitat at Beverley. These were less common in 2009, with no more than a few plants of any species being recorded. Weed species along the Four Mile Creek have come in as seeds from the Flinders Ranges, where alien species are more prevalent than on the plains at Beverley. Barker *et al.* (2005) list 20% of the species recorded in the Flinders Ranges botanical region as being introduced, while this figure is 15% for the Eastern botanic region, which includes the Beverley mine.

Twenty three alien species are now included in the list for the Beverley mine lease and surrounding areas. This is still less than 10% of the total plant list for the general area (Appendix F), which is slightly below the average for arid parts of South Australia reported by Badman (1995, 1999). However, the current list may still be incomplete because of the lack of significant rainfall in recent years. The majority of the alien species recorded in northern South Australia have Mediterranean or South African origins and favour winter rainfall (Badman 1995). Although there was above average winter rainfall in 2005, this did not necessarily result in the growth conditions that could have been produced in a higher rainfall year.

Several common introduced species which occur in the general area have yet to be recorded on the mine lease. These include *Asphodelus fistulosus* (Onion Weed), *Bromus rubens* (Red Brome), *Carrichtera annua* (Ward’s Weed), *Echium plantagineum* (Salvation Jane), *Erodium cicutarium* (Common Stork’s Bill) and *Marrubium vulgare* (Horehound). The latter is a proclaimed plant in South Australia and any occurrence of this species should be promptly dealt with. Other species may also be found following good rainfall, particularly if this occurs during the cooler months.

Salsola kali (*Salsola tragus*), the species reported as being the most common alien plant at the mine site (Fatchen Environmental 2002), is regarded as a cosmopolitan rather than an alien species (Lang and Kraehenbuehl 2008, Barker *et al.* 2005) and so should not be included in the list of alien plants.

6.2 NOTES ON INDIVIDUAL SPECIES

The following species have been recorded in or near the Beverley Mine Lease.

Acetosa vesicaria (Rosy Dock)

One immature plant was found in the camp area in September 2004. It was not recorded there in subsequent years. This species is abundant in the Flinders Ranges and periodically along Four Mile Creek.

Brassica tournefortii (Wild Turnip)

Several plants were recorded at monitoring site BU12A in September 2008 and it was recorded at monitoring site BE03 in 2009. This is a common species in sandy soils throughout the region and it is somewhat surprising that it was not recorded much earlier at Beverley, particularly in the sandy soils along the major creeks.

Cenchrus ciliaris (Buffel Grass)

This species was recorded during the 1979 biological survey (Williams 1979) and along the banks of Paralana Creek during some Epic Gas Pipeline surveys. This species has been widely planted for stock fodder by pastoralists in northern South Australia.

Centaurea melitensis (Malta Thistle)

Recorded during the 1979 biological survey² (Williams 1979), but not recorded during later monitoring events.

Centaureum erythraea (Common Centaury)

Recorded during the 1979 biological survey (Williams 1979), but not recorded during later monitoring events.

Chenopodium murale (Nettle-leaf Goosefoot)

This species was recorded during the 1979 biological survey (Williams 1979) and was recorded near the Four Mile Bore in September 2007 and in September 2009. It is common at many pastoral watering points and at sheep yards in northern South Australia and appears to benefit from the extra nutrients found at such places.

Citrullus colocynthis (Colocynth)

Not recorded during the 1979 biological survey (Williams 1979), but since recorded as sparsely present in some watercourses. This perennial species is very common in northern South Australia, particularly following late spring and summer rainfall.

Cucumis myriocarpus (Paddy Melon)

Williams (1979) recorded this species during the 1979 biological survey. It was also recorded at the Four Mile Bore in September 2009.

Cynodon dactylon (Couch)

Found in a drain just outside the main gate to the process plant since 2004, at Camp 1 and at the Four Mile Bore. This is a common species along drains and around water points throughout the surrounding pastoral country.

Datura leichhardtii (Native Thorn-apple)

² Williams listed *Centaurea solstitialis*, but this particular species was then known in South Australia only from Eyre Peninsula and the Northern Lofty botanical regions and further south (Lang and Kraehenbuehl 2002). The widespread *C. melitensis* is the only member of this genus which was then known from the botanical region containing the Beverley Mine. However, AVH (2007) now lists *C. solstitialis* for the Flinders Ranges botanical region and Barker et al (2005) list it as a questionable native for the Flinders Ranges region. It is still not shown for the Flinders Ranges area by AVH (2007).

One plant was found growing in a gully near the old camp site on the mine lease to the south of the Four Mile Bore in 2005. It has not been recorded since that time.

Heliotropium curassavicum (Smooth Heliotrope)

Williams (1979) recorded this species during the 1979 biological survey. It is common in good seasons in saline damp areas, including at the margins of salt lakes.

Lactuca serriola (Prickly Lettuce)

Williams (1979) recorded this species during the 1979 biological survey. It is found in many watercourses and other damp areas in the northern pastoral country of South Australia.

Malva parviflora (Mallow)

This species was recorded only during the December 2003 annual vegetation survey (Badman 2004a) and during the June 2004 Epic pipeline vegetation survey (Badman 2004b).

Mentha spicata (Spearment)

Williams (1979) recorded this species during the 1979 biological survey.

Neatostema apulum (Hairy Sheepweed)

A few plants were found in a small gully just to the west of the processing plant in September 2005.

Nicotiana glauca (Tree Tobacco)

A single plant was found growing on the bank of a pond within the process plant area in September 2007 and another single plant in the process plant car park in September 2009.

Polypogon monspeliensis (Annual Beard-grass)

This species was recorded in wet mud at the Four Mile Bore in 2004, 2005 and 2006 and in the drain from the camp kitchen in 2005 and 2006. It was also recorded at the tanks where water trucks were filled near the Four Mile Bore and in Jenny Creek during 2006. It was not recorded during the 2007 survey. This is a common species in many bore drain swamps and in some other permanently wet areas in northern South Australia. It was not recorded in 2008 and 2009, despite searches in areas where it was found in previous years.

Ricinus communis (Castor Oil Plant)

Williams (1979) recorded this species during the 1979 biological survey.

Schismus barbatus (Arabian Grass)

This species has been recorded in sandy monitoring quadrats in good seasons and also along the Epic Pipeline in all years since 2004. It is common in surrounding pastoral country following cool-season rainfall.

Sisymbrium erysimoides (Smooth Mustard)

Found in the drain from the camp kitchen in all years since 2004. It is common along the Four Mile Creek and in 2007 was found in many other wet places, including Camp 1, Four Mile Bore, and process plant area; and in other wet areas on the mine lease. It was far less common in 2009. This is a common species in wet, shaded habitats, particularly along watercourses, throughout the surrounding pastoral country.

Solanum nigrum (Black Nightshade)

Found in most places where water overflows from the camp and process plant in September 2004 and slightly less commonly in 2005; it was much less common in 2006, 2007, 2008 and 2009. It is common in similar habitats throughout much of the northern pastoral areas of South Australia.

Sonchus oleraceus (Common Sow-thistle)

Found regularly in a drain just outside the main gate to the process plant, within the process plant and in camp areas, although only a single plant was recorded in 2009. It was also found growing in many other wet areas on the mine lease. This is a common species along drains and around water points throughout the surrounding pastoral country.

Spergularia marina (Salt Sand-spurrey)

This species was moderately common in wet mud at the Four Mile Bore in 2004, and very common there in subsequent years. This species is restricted in this region to wet areas such as boredrains and tank overflows.

Tribulus terrestris (Caltrop)

Recorded in monitoring quadrats in some years and absent in others. It was very common and widespread in 2009. This proclaimed species is common in surrounding pastoral country (e.g. Badman 2010).

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8 FIGURES

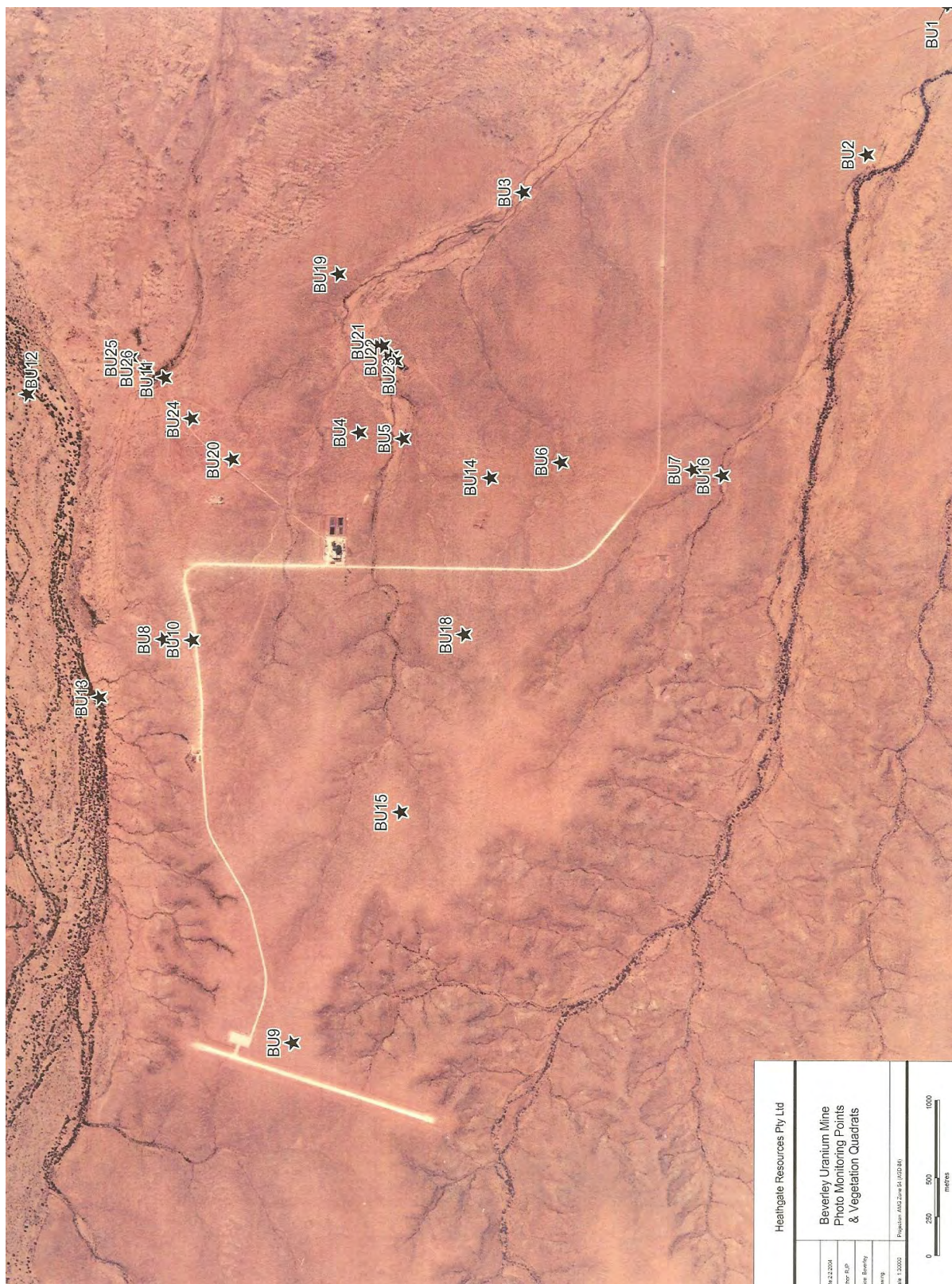


Figure 1: Location of Beverley Uranium Mine Vegetation Monitoring Sites

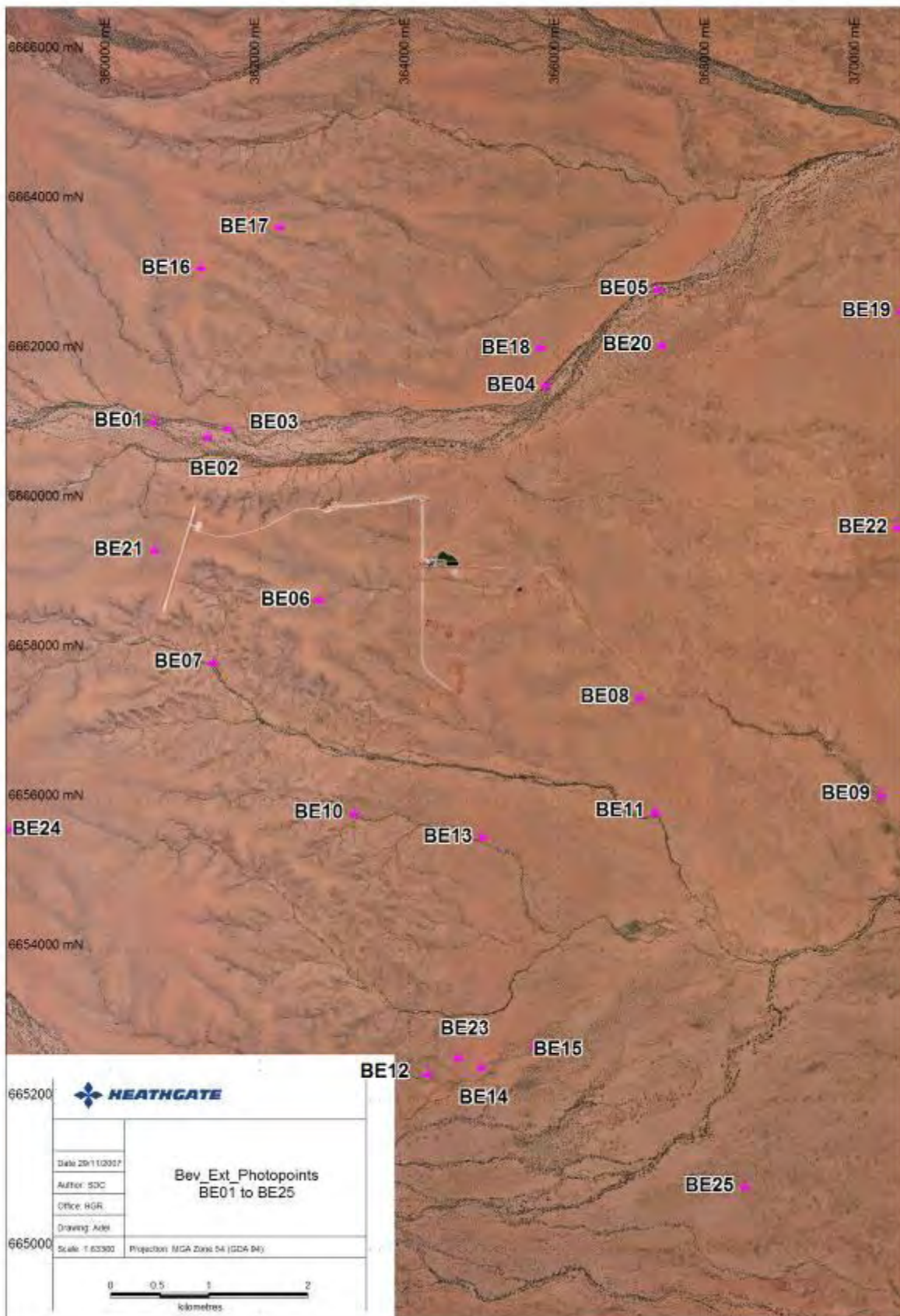
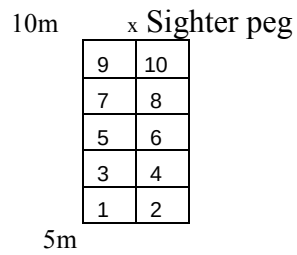


Figure 2: Location of Beverley Additional Leases Vegetation Monitoring Sites



* Photopoint peg

Figure 3: Layout of photopoint quadrat and cell numbering system

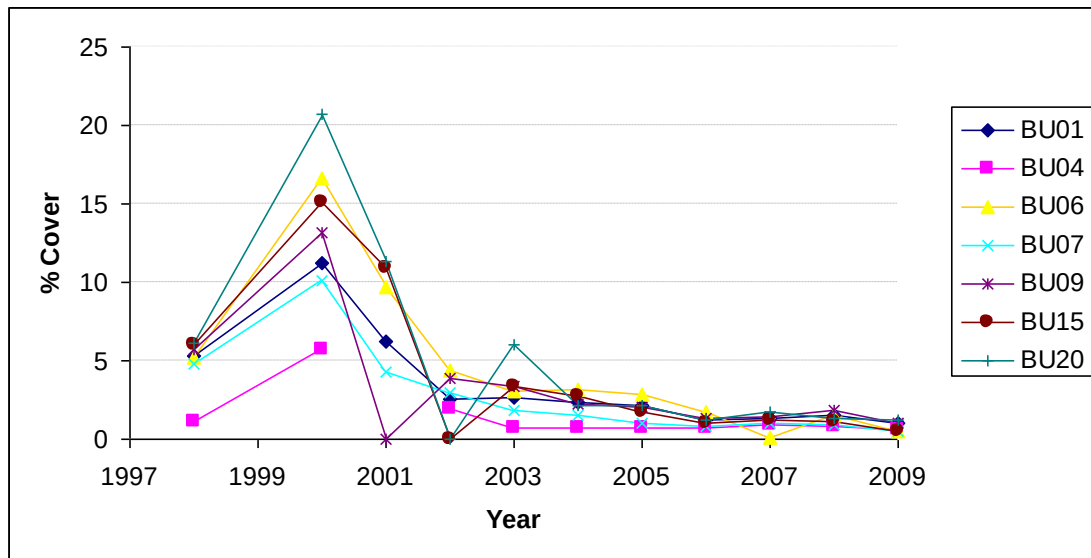


Figure 4: Summary of cover of *Astrebla pectinata* (Mitchell Grass), 1998-2009

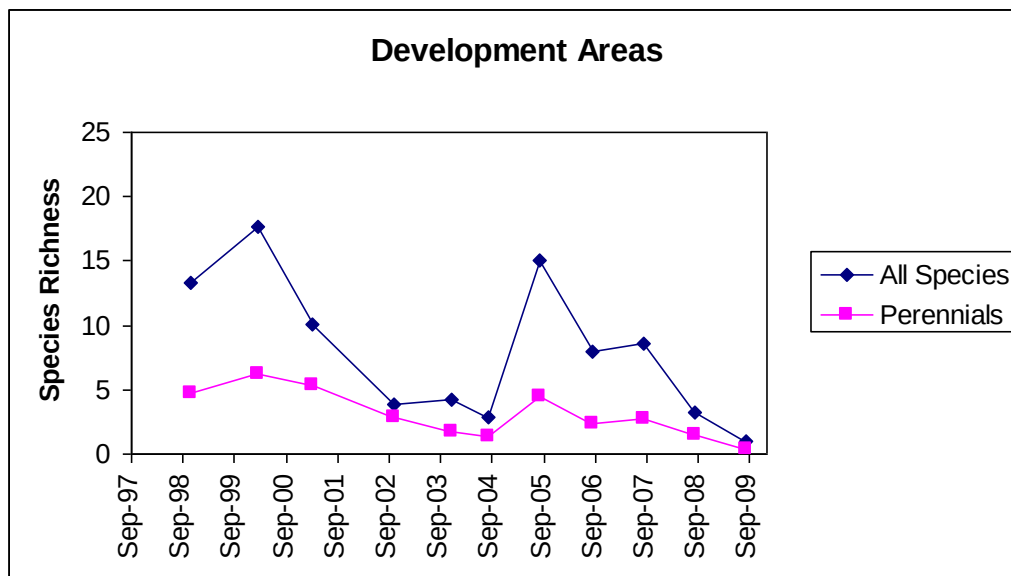


Figure 5: Summary of species richness for mining development areas

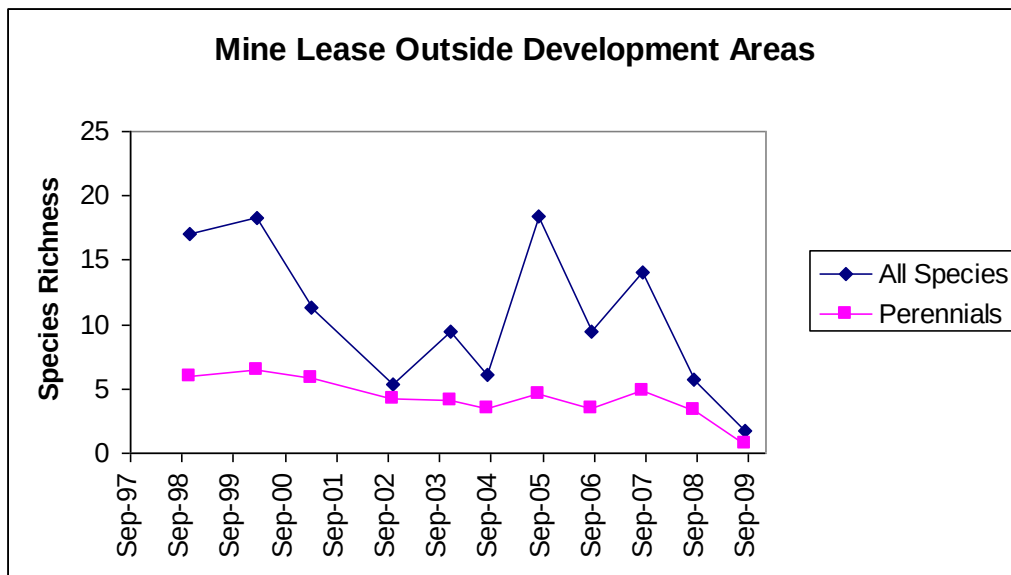


Figure 6: Summary of species richness for areas on the mine lease distant from development

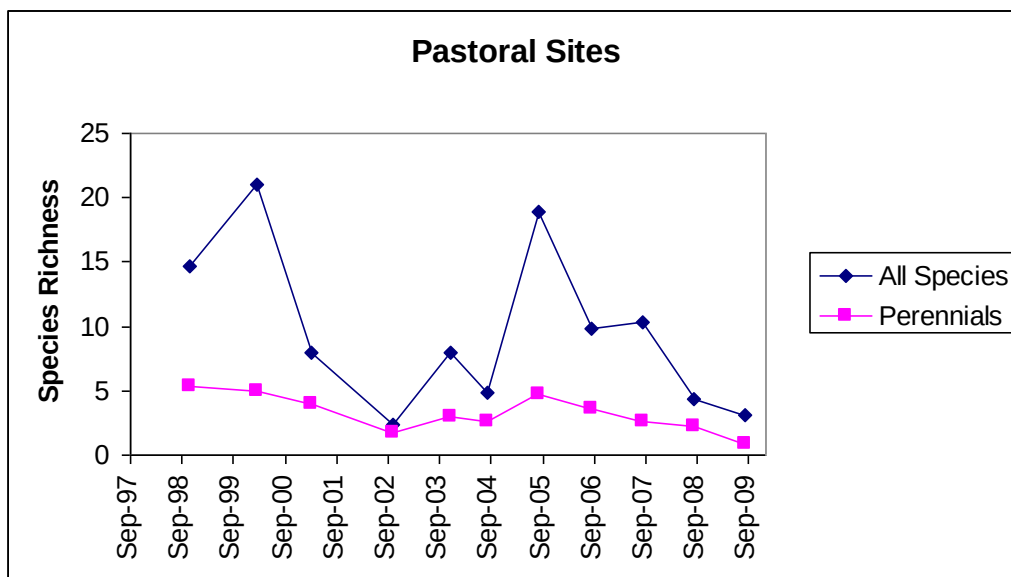


Figure 7: Summary of species richness for pastoral sites

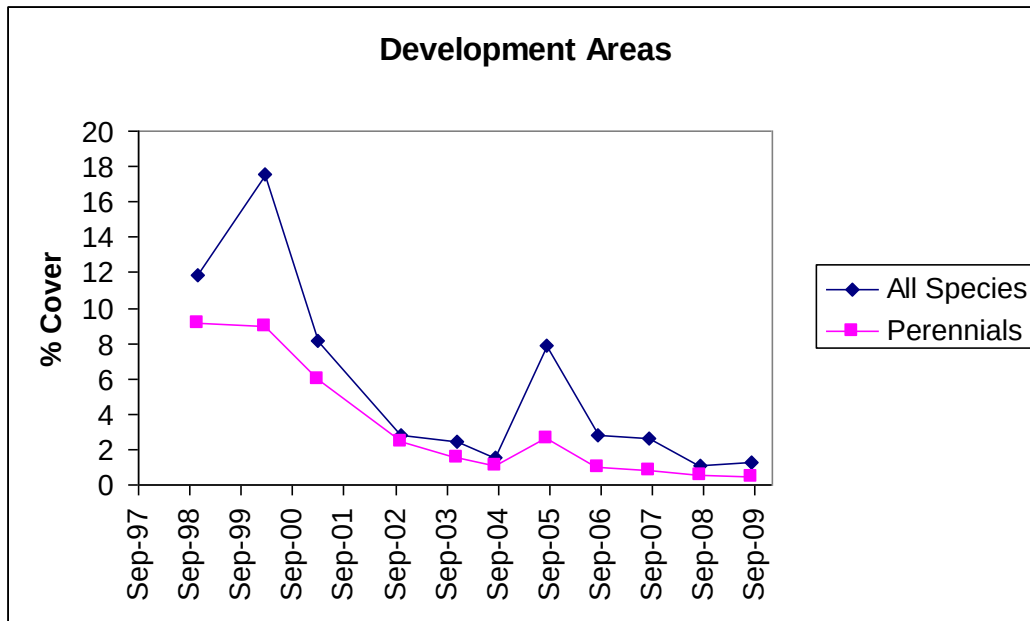


Figure 8: Summary of cover for mining development areas

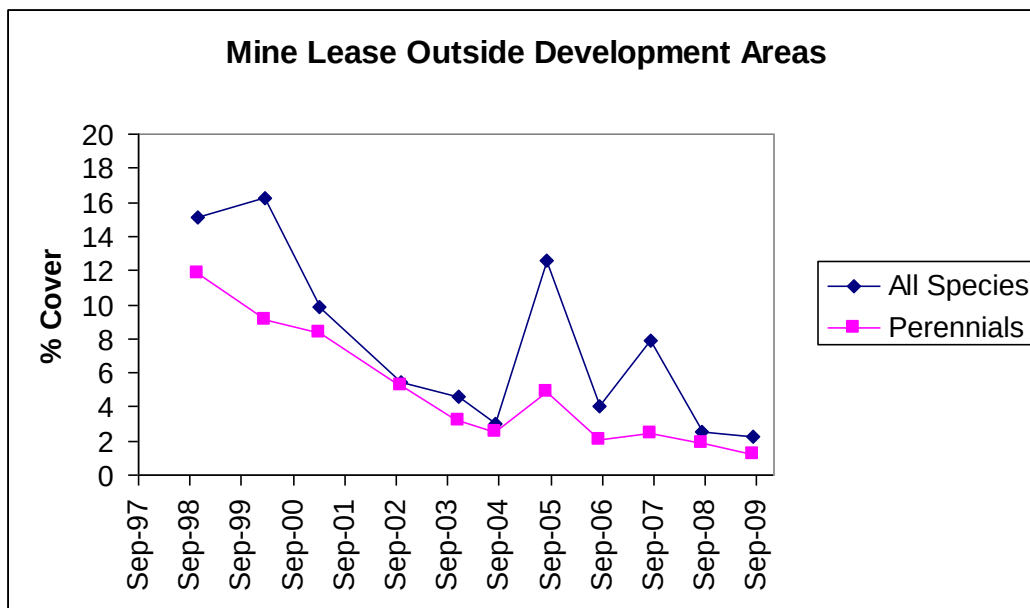


Figure 9: Summary of cover for areas on the mine lease but distant from development

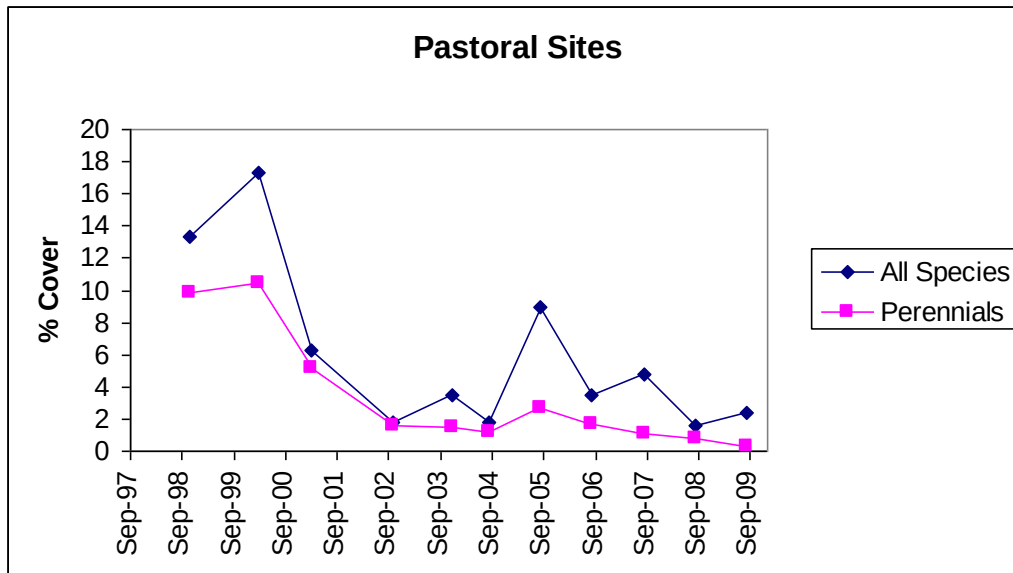


Figure 10: Summary of cover for pastoral sites

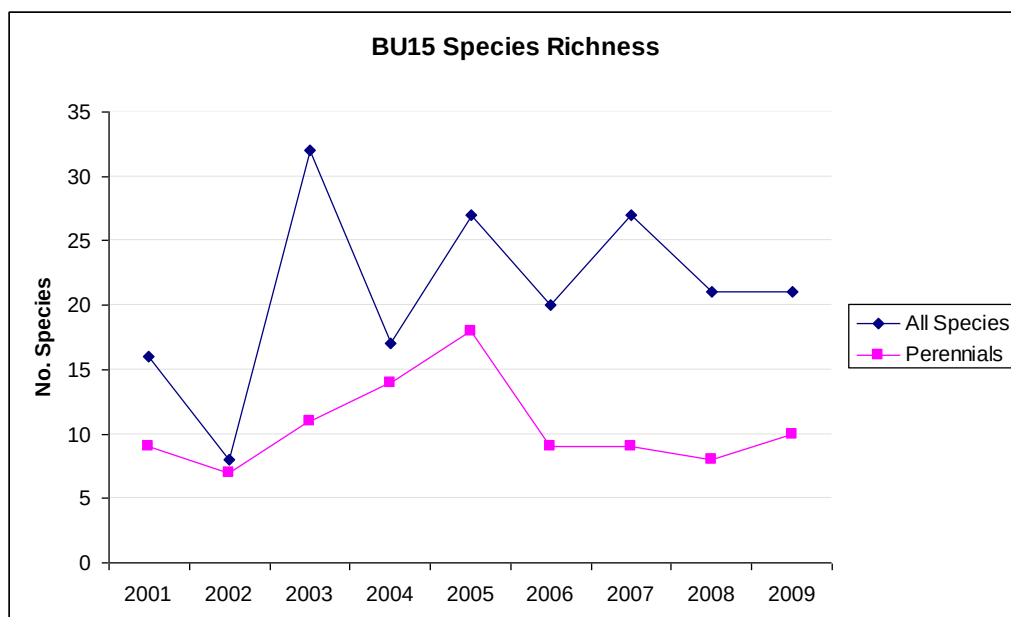


Figure 11: Species richness at the one hectare quadrat at BU15

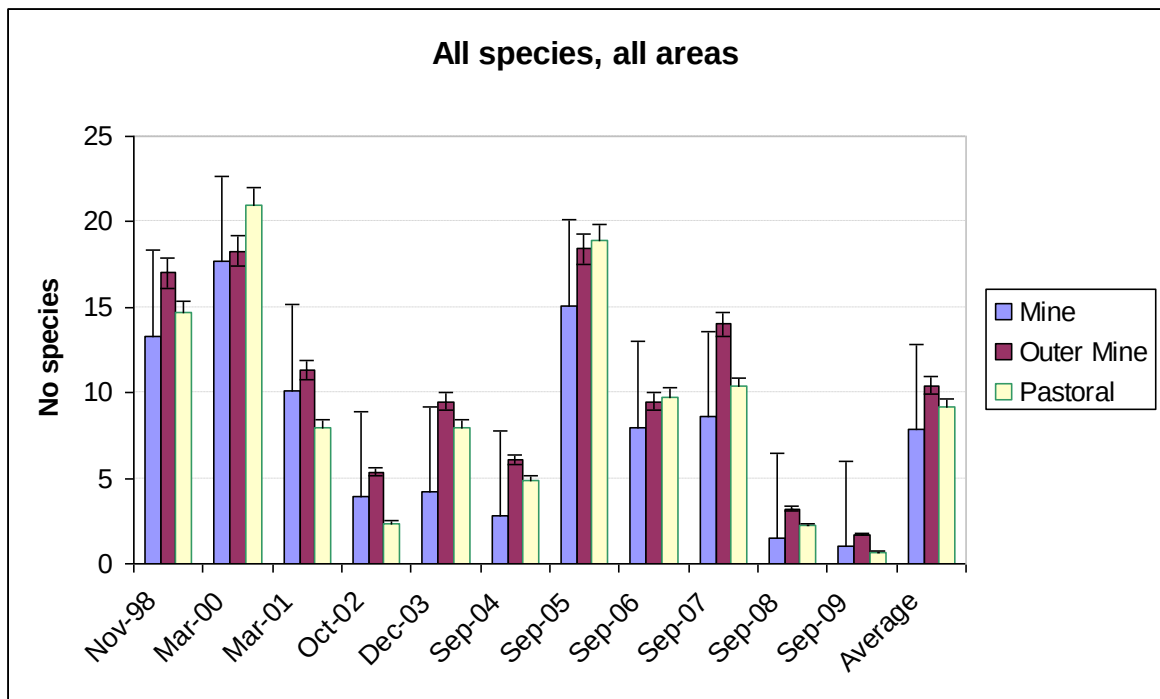


Figure 12: Comparison of Species richness of all species at all sites in all areas

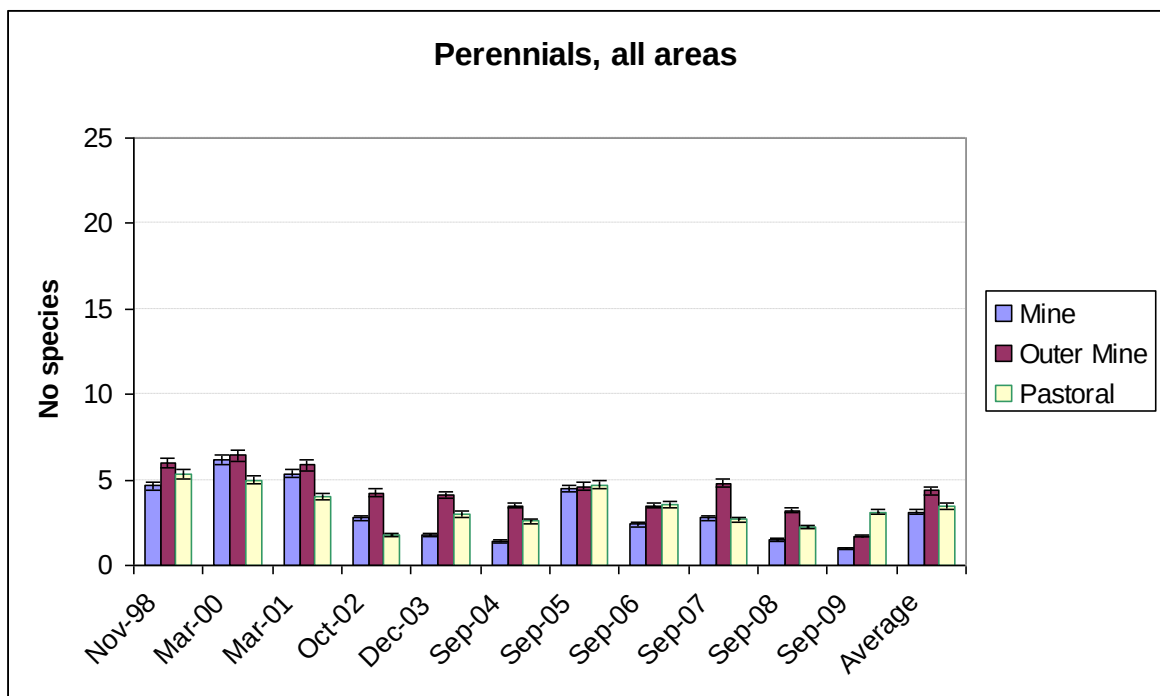


Figure 13: Comparison of Perennial Species richness at all sites in all areas

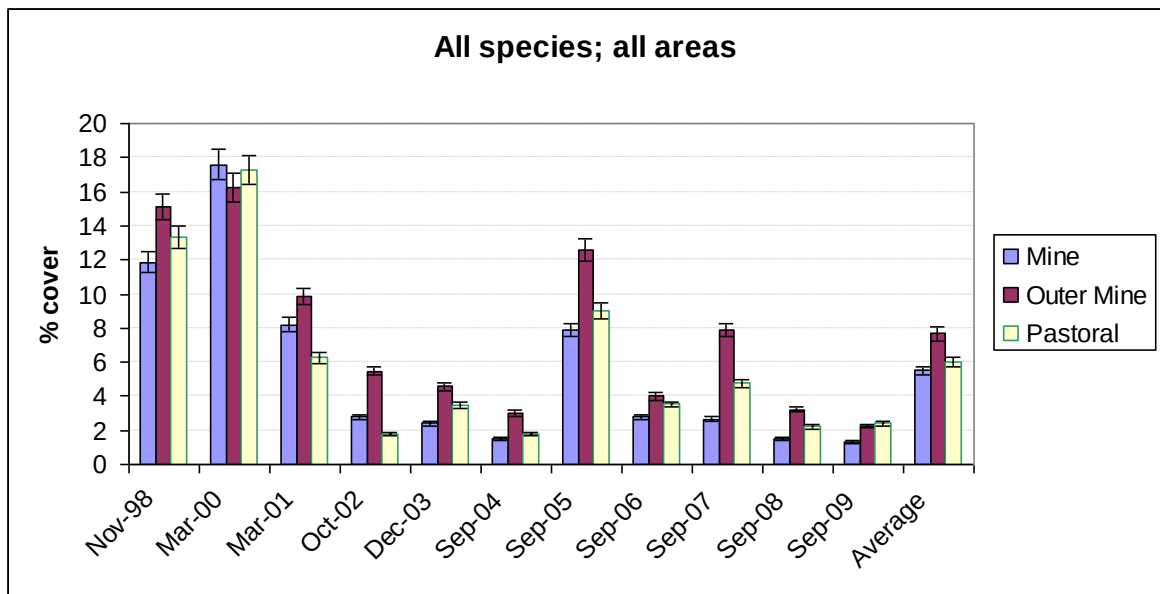


Figure 14: Comparison of Cover of all species at all sites in all areas

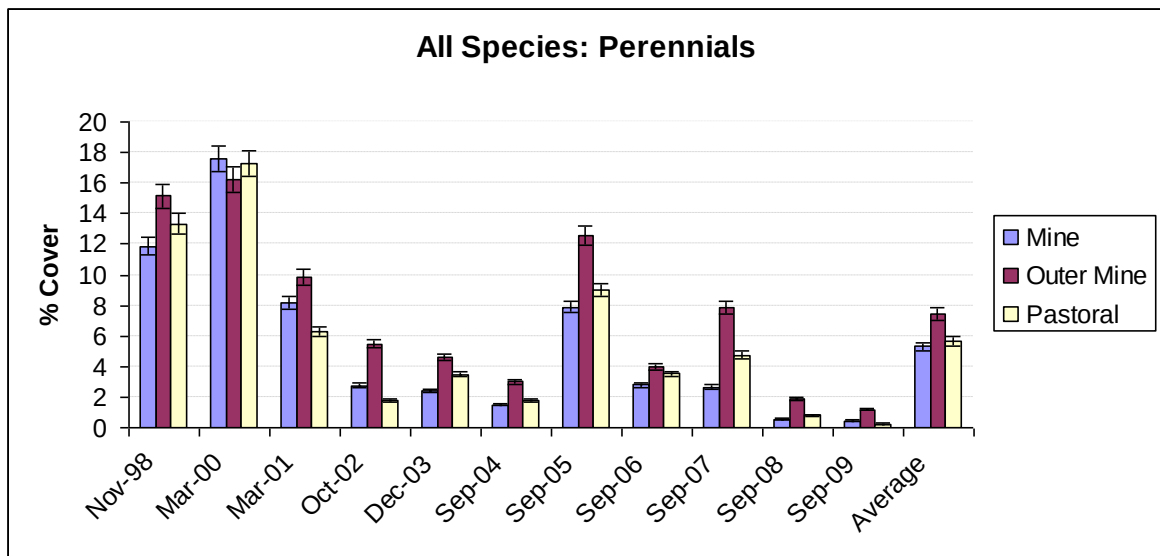


Figure 15: Comparison of Perennial Cover at all sites in all areas

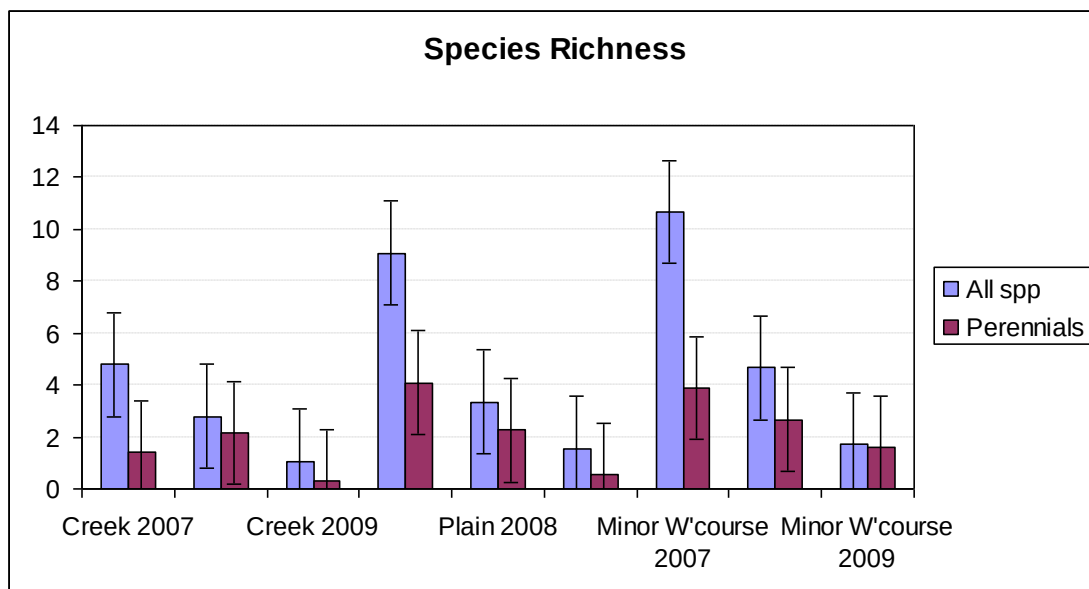


Figure 16: Summary of species richness for new development areas

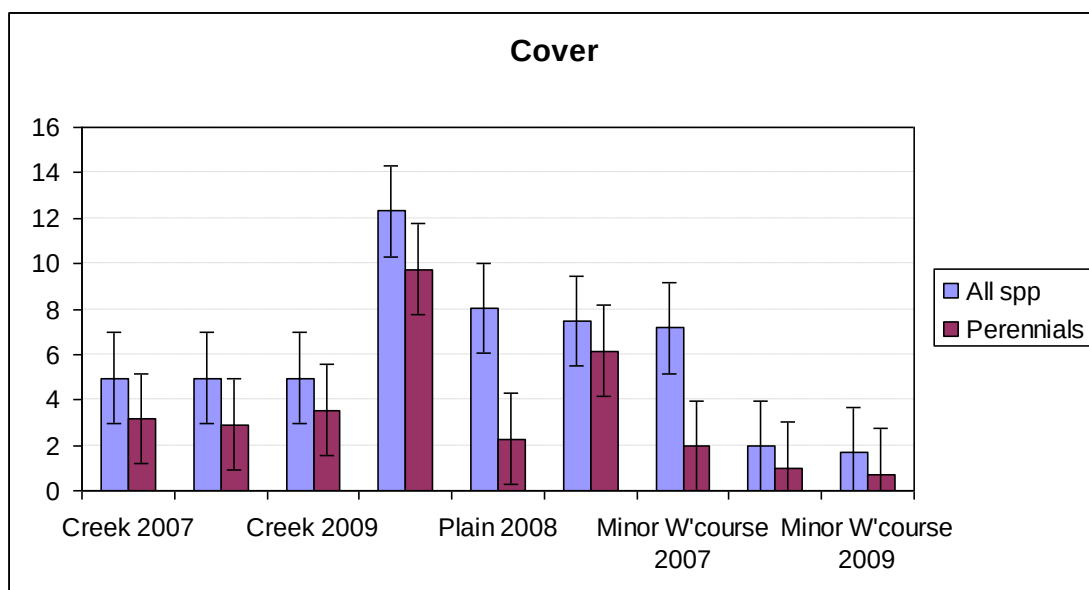


Figure 17: Summary of cover for new development areas

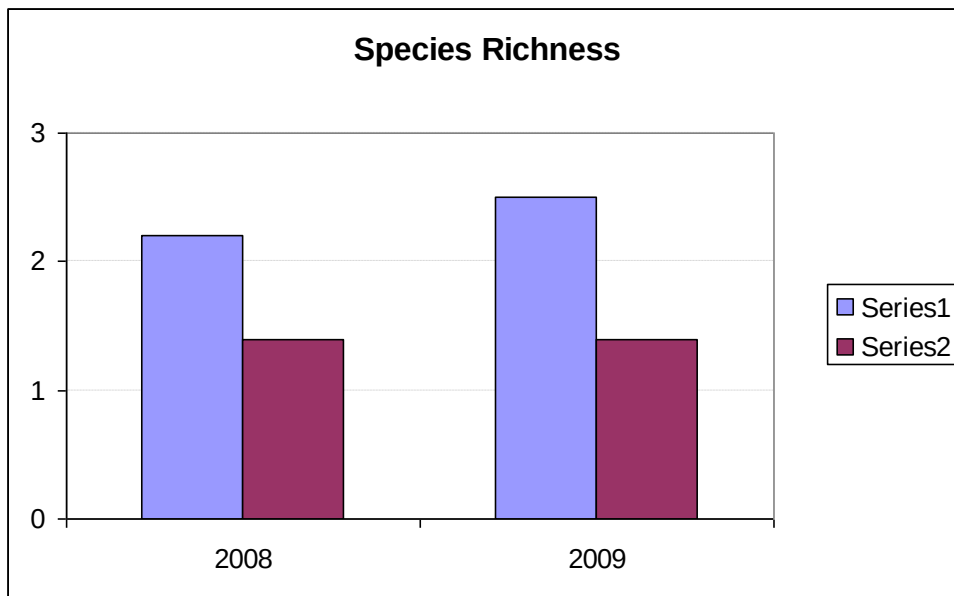


Figure 18: Summary of species richness for the new distant control sites

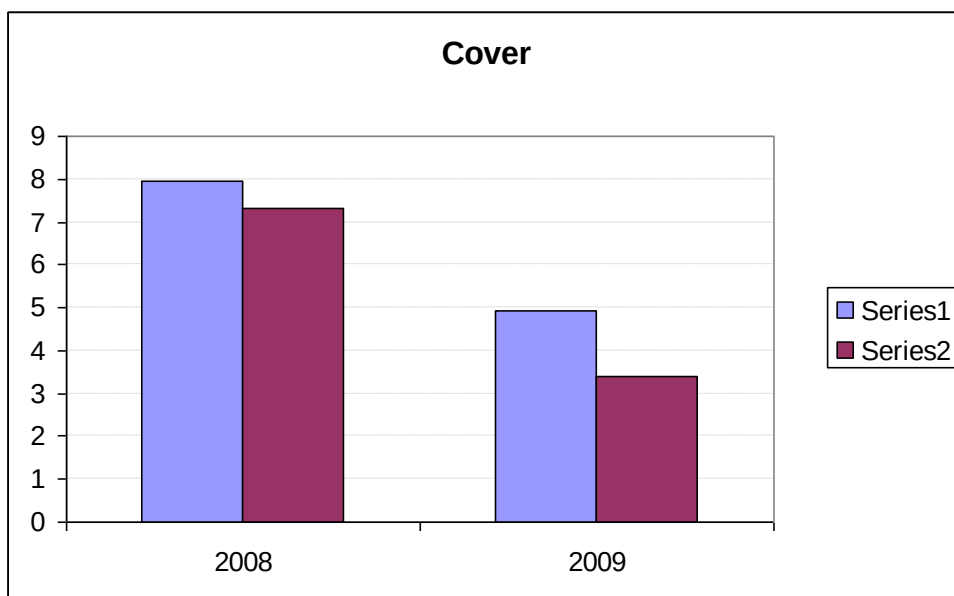


Figure 19: Summary of cover values for the new distant control sites

9 TABLES

Table 1: Location of photopoints and quadrats

Datum is WGS84		
Site	Easting	Northing
BU1	367715	6655699
BU2	366753	6656163
BU3	366553	6658161
BU4	365025	6659081
BU5	364979	6658835
BU6	364813	6657902
BU7	364754	6657137
BU8	363714	6660194
BU9	361109	6659388
BU10	363706	6660026
BU11	365398	6660218
BU12	365308	6661066
BU13A	363337	6660543
BU13B	363342	6660557
BU14	364723	6658312
BU15	362582	6658794
BU16A	364714	6656964
BU16B	364709	6656972
BU17	Now part of BU10	
BU18	363715	6658449
BU19	366045	6659220
BU20	364866	6659816
BU21	365588	6658954
BU22	365515	6658907
BU23	365481	6658883
BU24	365130	6660049
BU25	365524	6660412
BU26	365458	6660318
BE01	360594	6661076
BE02	361307	6660876
BE03	361577	6660989
BE04	365827	6661560
BE05	367324	6662853
BE06	362800	6658699
BE07	361380	6657857
BE08	367084	6657381
BE09	370301	6656084
BE10	363264	6655835
BE11	367283	6655862
BE12	364253	6652353
BE13	364980	6655527
BE14	364962	6652449
BE15	365676	6652738
BE16	361221	6663134
BE17	362273	6663676
BE18	365752	6662067
BE19	370570	6662553
BE20	367369	6662102
BE21	360600	6659356

Site	Easting	Northing
BE22	370524	6659668
BE23	364657	6652573
BE24	358690	6655623
BE25	368486	6650847
BE26	372042	6663822
BE27	372571	6657557
BE28	355951	6658233
BE29	362283	6649741
BE30	361461	6650572
BE31	364681	6665354

Table 2: Distribution of vegetation survey quadrats (5m x 2m)

Within Mine Site And Under Present Development (Within Ore Body)				Within Mine Site But Outside Development	Outside Mine Lease
Northern Ore Body – Northern Wellfield (already established)	Central Ore Body – new Central Wellfield	Northern Ore Body	Southern Ore Body	Not within Northern, Central or Southern Ore bodies	
BU24	BU21	BU11	BU6	BU4	BU1
BU25	BU22	BU20	BU14	BU5	BU2
BU26	BU23			BU8	BU3
				BU9	BU7
				BU10	BU12
				BU15 (also 100 x100m quadrat)	BU13
				BU17 (now part of BU10)	BU16
				BU18	
				BU19	
				BU27	

Table 3: Photographic Summary Information³

Site	Foreground	Background	Land Use	Sept 2008	December 2008	March 2009	June 2009	Sept 2009
BU1	Mitchell grass	Red gum	Pastoral	Condition of vegetation continues to deteriorate	Vegetation very dry, with less cover of understorey plants	Vegetation very dry, with less cover of understorey plants	Condition of vegetation continues to deteriorate	Condition of vegetation continues to deteriorate
BU2	Sclerolaena spp.	Acacia victoriae	Pastoral	No understorey species visible in creek	Vegetation very dry, with less cover of understorey plants	Very little understorey vegetation remaining	No understorey vegetation left in foreground	No understorey species visible anywhere
BU3A (BU3W)	Vegetation monitoring quadrat. Maireana aphylla, grasses	M.aphylla, grasses A.victoriae	Pastoral	All vegetation in poor condition, although shrubs are in better condition than ephemerals.	Pools of water in middle distance. Little change to vegetation.	Some new growth of ephemerals	More growth of ephemerals; shrubs in slightly better condition.	Little change
BU3B	Maireana aphylla, grasses	M.aphylla, grasses A.victoriae	Pastoral	Foreground vegetation almost gone. Little change in shrubs	Some new growth of ephemerals	More new growth of ephemerals	Little change.	Foreground vegetation almost gone. Little change in shrubs
BU4A	Sclerolaena divaricata, Astrebla pectinata	Process Plant Shrubland on Jenny Creek	Mine lease, no development	Little change Ephemerals almost gone	Some new ephemerals visible.	Ephemerals have dried off, but more than in December. Shrubs in middle distance in better condition.	Little change, but shrubs not quite as green.	Little change
BU4B (BU4E)	Sclerolaena divaricata, Astrebla pectinata	Eremophila, FLT slopes	Mine lease, no development.	Little change	Vegetation all dried off.	Little change.	Little change.	Little change

³ Description of foreground for BU sites is as described in the Baseline Report. No sites were dominated by Mitchell Grass in 2008-09 (see Figure 4 of this report)..

BU4C (BU4W)	Vegetation monitoring quadrat. <i>Sclerolaena divaricata</i> , <i>Astrebla pectinata</i>	Southern Ore Body. <i>Sclerolaena divaricata</i> , <i>Astrebla pectinata</i>	Mine lease, no development. Process plant in distance	Vegetation all dry; little change in cover.	Vegetation all dry; little change in cover.	Little change.	Little change.	Little change
BU5A (BU5E)	Vegetation monitoring quadrat. Mixed shrubland and same tall open shrubland on Jenny Creek	Mixed shrubland and same tall open shrubland on Jenny Creek	Mine lease, no development. FLT plant visible	Shrubs drier; very limited growth of ephemerals.	Few tiny dry plants in understorey; all shrubs in poor condition	Some new growth of ephemerals.	Little change	Little change in shrubs; most understorey plants have gone
BU5B	Ephemerals on floodplain	Shrubland on Jenny Creek	Mine lease, no development	Shrubs drier; very limited growth of ephemerals.	Few tiny dry plants in understorey; all shrubs in poor condition	Some new growth of ephemerals.	Little change	Little change in shrubs; most understorey plants have gone
BU6A	Vegetation monitoring quadrat. <i>Astrebla pectinata</i>	<i>Astrebla pectinata</i>	Southern ore body	All vegetation very dry.	Little change	Little change	Little change	Little change. Construction work on trunk pipeline in middle distance
BU6B (BU6N)	<i>Astrebla pectinata</i>	<i>Astrebla pectinata</i>	Southern ore body. FLT plant visible	All vegetation very dry.	Little change	Little change	Little change	Little change
BU7	<i>Astrebla pectinata</i>	<i>Eremophila freelingii</i> on drainage	Pastoral	All vegetation very dry.	Little change	Little change	Little change	Groundcover species almost gone
BU8A	Vegetation monitoring quadrat. <i>Astrebla pectinata</i> , <i>Sclerolaena divaricata</i>	Red gum and <i>Melaleuca</i> in Four Mile Creek	Mine lease, no development. Drillers camp, 4 Mile Bore	All vegetation very dry.	Little change	Little change	Little change	Little change

BU8B	Astrebla pectinata, Sclerolaena divaricata	Astrebla pectinata, Sclerolaena divaricata	Mine lease, no development. Main camp	All vegetation very dry.	Little change	Little change	Little change	Little change
BU9A	Vegetation monitoring quadrat. Astrebla pectinata	Astrebla pectinata	Mine lease, no development. Airport surrounds	Little change from September 2008.	Most vegetation very dry and slightly less than in previous quarter.	Little change	Little change	Much less vegetation and all dried off
BU9B (BU9N)	Astrebla pectinata	Astrebla pectinata	Mine lease, no development. Airport surrounds, strip visible	Little change from September 2008 except new shed at airport.	Most vegetation very dry and slightly less than in previous quarter.	Little change	Little change	Few green forbs, but most vegetation very dry
BU10A	Vegetation monitoring quadrat faces Give Way sign. Eragrostis spp with Eremophila latrobei and E.freelingii	Eragrostis spp with Eremophila latrobei and E.freelingii	Mine lease, no development. Camp access; plant in background	Less understorey species present.	Little change	Little change to vegetation. Road sign missing from middle distance.	Few additional ephemeral species present.	Vegetation drier, especially shrubs which have lost many leaves. Less construction activity visible in distance
BU10 B (includes BU17)	Eragrostis spp with Eremophila latrobei and E.freelingii	Eragrostis spp with Eremophila latrobei and E.freelingii	Mine lease, no development. Camp access	Less understorey species present.	Little change	Little change to vegetation.	Few additional ephemeral species present.	Little change
BU11	Terrace: Rhagodia spinescens and frontage grasses	A.victoriae tall shrubland	Northern ore body	Foliage on many tall shrubs now very sparse; all understorey species have gone	Little change	Increase in number of ephemeral herbs present.	Little change to shrubs, slightly greater cover of herbs.	Foliage on many tall shrubs now very sparse; most of understorey species have gone

BU12A	Vegetation monitoring quadrat. Alluvium with Melaleuca lanceolata canopies	Interfluvium with red gum fringing woodland	Pastoral	All green herbs have dried off; little change to other vegetation	All vegetation very dry; almost no understorey	Good cover of dried off understorey herbs.	Far less understorey plants present.	All green herbs have dried off; little change to other vegetation
BU12B	Alluvium with Melaleuca lanceolata canopies	Interfluvium with Melaleuca fringing tall shrubland	Pastoral	All green herbs have dried off; little change to other vegetation	All vegetation very dry; almost no understorey	Little change	Few green herbs beneath tall shrubs; all other vegetation very dry with sparse cover	All green herbs have dried off; little change to other vegetation
BU13A	Vegetation monitoring quadrat. Ephemeral/bare	Eremophila longifolia stand	Pastoral	Foreground bare of understorey plants	Almost no understorey; Eremophilas very dry and missing many leaves	Little change	Slight increase in number of understorey plants.	Tall shrubs look worse; no understorey
BU13B	Vegetation monitoring quadrat. Ephemeral/bare	Melaleuca lanceolata thicket with emergent red gum	Pastoral	Tall shrubs look worse; no understorey	Almost no understorey; trees and shrubs very dry	Little change	Little change	Tall shrubs look worse; no understorey
BU14	Astrebla pectinata, Sclerolaena divaricata	Cuttings pit	Southern ore body	Very few plants visible in foreground of photograph.	Slight increase in vegetative cover.	Slight increase in vegetative cover.	Little change	Condition of vegetation has deteriorated further
BU15A	Vegetation monitoring quadrat. Astrebla pectinata, Sclerolaena divaricata	Astrebla pectinata, Sclerolaena divaricata	Mine lease, no development	Much drier and some of vegetation has gone	New growth in most forbs and cover still reasonable	All vegetation dried off	Little change	Much drier and some of vegetation has gone
BU15B (BU15N)	Astrebla pectinata, Sclerolaena divaricata	Astrebla pectinata, Sclerolaena divaricata	Mine lease, no development	Much drier and some of vegetation has gone	New growth in most forbs and cover still reasonable	All vegetation dried off	Little change	Much drier and some plants have gone

BU16A (BU16N)	Vegetation monitoring quadrat. Astrebla pectinata, Sclerolaena divaricata	Astrebla pectinata, Sclerolaena divaricata	Pastoral	No herbs present in the understorey.	Few herbs present in the understorey.	Understorey herbs mainly dried off.	Little change	Little change
BU16B (BU16S)	Vegetation monitoring quadrat. Astrebla pectinata, Sclerolaena divaricata	Acacia-Santalum -Senna tall shrubland in creek line	Pastoral	Only remaining understorey species are in gilgai.	Little change	More understorey species present, but all dried off.	Little change	Little change
BU18A	Astrebla pectinata, Sclerolaena divaricata	Astrebla pectinata, Sclerolaena divaricata	Mine lease, no development. Camp visible	Few species visible in photograph.	Little change	Little change	Little change	Little change
BU18B	Vegetation monitoring quadrat. Astrebla pectinata , Sclerolaena divaricata	Astrebla pectinata , Sclerolaena divaricata	Mine lease, no development	Limited number of forbs visible in photograph; no ephemerals.	Little change	Little change	Little change	New minor pipeline visible in middle distance. Little change to vegetation.
BU18C	Astrebla pectinata , Sclerolaena divaricata	Astrebla pectinata , Sclerolaena divaricata	Mine lease, no development. FLT visible	Increase in growth of forbs in foreground, but no ephemerals visible.	Little change	Little change	Little change	Little change
BU19A	Astrebla pectinata , Sclerolaena divaricata	Eremophila, A.victoriae and other tall shrubs in creek	Mine lease, no development, FLT visible	Increase in growth of forbs in foreground and middle distance, but no ephemerals visible.	Little change	Little change	Little change	Little change

BU19B	Vegetation monitoring quadrat. <i>Astrebla pectinata</i> , <i>Sclerolaena divaricata</i>	<i>Eremophila</i> , <i>A.victoriae</i> and other tall shrubs in creek	Mine lease, no development. Main plant visible	Little change since June 2008.	Little change	Increase in cover of forbs.	Little change	Little change
BU20A	Vegetation monitoring quadrat. <i>Astrebla pectinata</i>	Cleared pad	Northern ore body; injection wells	Only one water tank remaining. Vegetation very sparse.	Water tank has been removed. Slight increase in vegetation.	Slight increase in vegetation, all very dry.	Little change	Little change
BU20B (BU20S)	<i>Astrebla pectinata</i>	<i>Astrebla pectinata</i>	Northern ore body; trunk pipeline and main plant	Vegetation very sparse.	Slight increase in vegetation, all very dry.	Slight increase in vegetation, all very dry.	Little change	Little change
BU21	Cleared pad	<i>M.aphylla</i> and <i>Acacia aneura</i> in Jenny Creek	Central wellfield; FLT central array	Foreground almost devoid of vegetation.	Few more plants visible in foreground.	Few more plants visible in foreground.	Little change	Little change
BU22	Cleared pad, pipelines	<i>M.aphylla</i> and <i>Acacia aneura</i> in Jenny Creek	Central wellfield	Foreground almost devoid of vegetation.	Few more plants visible in foreground.	Few more plants visible in foreground.	Little change	Windrow in centre foreground is more pronounced. Deterioration of vegetation.
BU23	Cleared pad	Cleared pad	Central wellfield; FLT pipelines and creek crossing	Foreground almost devoid of vegetation, but many new light vehicle wheel tracks..	Few more plants visible in foreground.	Increased cover of plants visible in foreground.	Little change	Little change
BU24	Cleared pad	Cleared pad	Northern wellfield	Very limited growth of herbs in foreground.	Few more plants visible in foreground.	Few more plants visible in foreground.	Little change	Little change
BU25	Natural bare pebbly ground	Cleared pad	Northern wellfield	Very little vegetation in foreground and middle distance.	Few more plants visible in foreground.	Very little vegetation in foreground and middle distance.	Little change	Little change

BU26	Astrebla pectinata on gibber	A.victoriae dense tall shrubland on creek line	Northern wellfield	Very little vegetation in foreground and middle distance.	Few more plants visible in foreground.	Little change	Little change	Little change
BU27	Naturally bare pebbly ground with a few forbs	Flowing bore and wetland; red gums along Four-mile Creek	Pastoral	Very little vegetation in foreground and middle distance.	Very little vegetation in foreground and middle distance.	Few more plants visible in foreground.	Little change	Little change
BE01	Vegetation monitoring quadrat in Four Mile Creek Stony creek bank with Acacia, chenopod shrubs and forbs. Dead Acacia.	Creek flat with Acacia tall shrubs.	Mine lease, no development	Very dry; no groundcover species present.	Little change.	Little change.	Few understorey species now present.	Little change
BE02	Vegetation monitoring quadrat in Four Mile Creek Stony creek bed with little vegetation.	Creek channel with Eucalyptus camaldulensis and Melaleuca.	Mine lease, no development	Very dry; few groundcover species present.	Little change.	Little change.	Many forbs now present in understorey.	Little change
BE03	Vegetation monitoring quadrat in Four Mile Creek Stony creek bed with little vegetation.	Creek channel with Eucalyptus camaldulensis and Melaleuca.	Mine lease, no development	Very dry; few groundcover species present.	Little change.	Little change.	Many forbs now present in understorey.	Little change

BE04	Vegetation monitoring quadrat in Four Mile Creek Stony creek bed with little vegetation.	Creek channel with Eucalyptus camaldulensis and Melaleuca.	Mine lease, no development	Very dry; few groundcover species present.	Little change.	Little change.	Many forbs now present in understorey.	Vegetation in gully in middle distance is less distinct.
BE05	Vegetation monitoring quadrat in Four Mile Creek Pebbly creek bed with little vegetation, but large dead Eucalyptus camaldulensis in middle distance.	Creek channel with Eucalyptus camaldulensis and Melaleuca.	Mine lease, no development	Very dry; few groundcover species present.	Little change.	Little change.	Increase in understorey species, but all dried off.	Little change
BE06	Vegetation monitoring quadrat on stony tableland. Sparse vegetation of sub-shrubs	Stony tableland.	Mine lease, no development	Sparse cover of dry chenopod forbs.	Increased ground cover.	Little change.	Little change.	Little change
BE07	Vegetation monitoring quadrat on clay creek flat. Sparse vegetation of sub-shrubs	Woodland/tall shrubland along minor watercourse	Mine lease, no development	Almost bare flat in foreground; good cover in watercourse.	Little change.	Little change.	Little change.	Little change

BE08	Vegetation monitoring quadrat on stony tableland. Sparse vegetation of chenopod forbs.	Woodland along creek line in far distance.	Mine lease, no development	Sparse cover in foreground.	Little change.	Little change.	Little change.	Little change
BE09	Vegetation monitoring quadrat in minor watercourse. Tall shrubs of Eremophila and Acacia spp.	Eremophila and Acacia tall shrubs along watercourse..	Pastoral.	Good cover of Rhagodia spinescens and emergent taller shrubs and small trees. Little understorey.	Little change.	Little change.	Small increase in groundcover herbs.	Little change
BE10	Vegetation monitoring quadrat on clay creek flat. Sparse vegetation of sub-shrubs	Stony country; tall shrubland with emergent small trees along minor watercourse	Mine lease, no development	Almost bare flat in foreground; good cover in watercourse.	Little change.	Little change.	Little change.	Little change
BE11	Vegetation monitoring quadrat in minor watercourse. Hakea leucoptera and chenopod shrubs. Limited understorey.	Woodland along larger watercourse.	Mine lease, no development	Trees and tall shrubs in good condition; Few understorey species present.	Little change	Little change	Little change	Little change

BE12	Vegetation monitoring quadrat in minor watercourse. Stony gully with tall shrubland of <i>Acacia tetragonophyll</i> a.	Larger watercourse; limited cover in the understorey	Pastoral.	Good cover of shrubs in gully, almost no understorey species.	Little change.	Little change.	Little change.	Little change
BE13	Vegetation monitoring quadrat on edge of minor watercourse. Flat with tall shrubland of <i>Eremophila</i> spp. and <i>Santalum lanceolatum</i> .	Minor watercourse with <i>Acacia</i> and <i>Eremophila</i> .	Mine lease, no development	Good shrub cover, but very limited understorey.	Little change.	Little change.	Little change.	Little change
BE14	Vegetation monitoring quadrat on clay plain. Flat with tall shrubland of <i>Rhagodia spinescens</i> and emergent <i>Santalum lanceolatum</i> .	<i>Acacia aneura</i> and <i>Rhagodia spinescens</i> .	Pastoral.	Good shrub cover, but very limited understorey.	Little change.	Little change.	Little change.	Little change

BE15	Vegetation monitoring quadrat on clay plain. Flat with tall shrubland of Rhagodia spinescens and emergent Santalum lanceolatum.	Acacia aneura and Rhagodia spinescens.	Pastoral.	Good shrub cover, but very limited understorey.	Little change.	Little change.	Little change.	Little change
BE16	Vegetation monitoring quadrat on cracking clay plain. Chenopod forbs.	Chenopod forbs.	Mine lease, no development.	Sparse cover of forbs.	Little change.	Little change.	Slight improvement in cover of forbs.	Little change
BE17	Vegetation monitoring quadrat on cracking clay plain. Chenopod forbs.	Small watercourse with taller shrubland.	Mine lease, no development.	Sparse cover of forbs.	Little change.	Little change.	Slight improvement in cover of forbs.	Little change
BE18	Vegetation monitoring quadrat on stony clay plain. Chenopod forbs.	Woodlands of Four Mile Creek.	Mine lease, no development.	Sparse cover of chenopod forbs.	Little change.	Little change.	Little change.	Little change

BE19	Vegetation monitoring quadrat on pebbly clay plain. Chenopod forbs.	Chenopod forbs on clay plain.	Pastoral.	Sparse, dry chenopod forbs.	Little change.	Little change.	Slight improvement of understorey cover.	Little change
BE20	Vegetation monitoring quadrat on clay plain. Limited cover of ephemerals and grasses..	Low chenopod shrubland with emergent mulga; limited understorey.	Mine lease, no development.	Good shrub cover; limited understorey.	Little change.	Little change.	Slight improvement of understorey cover.	Little change
BE21	Vegetation monitoring quadrat on stony plain. Limited cover of forbs.	Limited cover of forbs.	Mine lease, no development.	Limited understorey of forbs.	Little change.	Little change.	Slight improvement of understorey cover.	Little change
BE22	Vegetation monitoring quadrat on clay plain. Limited cover of forbs.	Riparian woodland along watercourse.	Pastoral.	Limited understorey of forbs.	Decrease in understorey cover.	Little change.	Slight improvement of understorey cover.	Little change
BE23	Vegetation monitoring quadrat on stony clay plain. Chenopod forbs.	Tall shrubland along watercourse.	Pastoral.	Limited understorey of forbs.	Little change.	Little change.	Slight improvement of understorey cover.	Little change

BE24	Vegetation monitoring quadrat on stony clay plain. Chenopod forbs.	Chenopod forbs on stony plain.	Control site >5 km from Four Mile ore bodies.	Limited understorey of forbs.	Little change.	Little change.	Slight improvement of understorey cover.	Little change
BE25	Vegetation monitoring quadrat on sparsely stony plain. Chenopod shrubs with little understorey..	Chenopod low shrubland.	Control site >5 km from Four Mile ore bodies.	Shrubs in fair condition, almost no understorey.	Little change.	Little change.	Little change.	Little change
BE26	Distant vegetation monitoring control site on clay plain. Chenopod shrubland with limited understorey.	Chenopod shrubland on plain.	Control site >5 km from Four Mile ore bodies.	Shrubs in fair condition, almost no understorey.	Little change.	Little change.	Little change.	Some improvement in understorey.
BE27	Distant vegetation monitoring control site on clay plain. Chenopod shrubland with limited understorey.	Riparian woodland/tall shrubland along watercourse.	Control site >5 km from Four Mile ore bodies.	Shrubs in fair condition, some new growth in understorey.	Little change, but new growth has all dried off.	Little change.	Little change.	Some improvement in understorey, especially of grasses.

BE28	Distant vegetation monitoring control site on stony clay plain. Chenopod shrubland with limited understorey.	Riparian woodland of Paralana Creek.	Control site >5 km from Four Mile ore bodies.	Sparse understorey vegetation is all very dry.	Little change.	Little change.	Some new growth of forbs in foreground.	Foreground understorey now all dried off.
BE29	Distant vegetation monitoring control site in minor watercourse. Chenopod shrubland with limited understorey.	Riparian woodland of Paralana Creek.	Control site >5 km from Four Mile ore bodies.	Vegetation is all very dry.	Little change.	Little change.	Little change.	Little change
BE30	Distant vegetation monitoring control site on stony clay plain. Chenopod shrubland with limited understorey.	Riparian woodland of Paralana Creek.	Control site >5 km from Four Mile ore bodies.	Vegetation is all very dry.	Little change.	Little change.	Little change.	Little change
BE31	Distant vegetation monitoring control site on pebbly clay plain. Chenopod forbs.	Chenopod forbs.	Pastoral.	Vegetation is all very dry.	Little change.	Little change.	Little change.	Little change

Table 4: Species Richness and Cover Summary

Development Areas

	September 2008				September 2009				% Change			
	Species Richness	Perennial /Biennial Richness	Total Cover	Perennial Cover	Species Richness	Perennial /Biennial Richness	Total Cover	Perennial Cover	Species Richness	Perennial/B iennial Richness	Total Cover	Perennial Cover
BU4	6	2	1.4	1.2	4	1	2	0.6	-33.3	-50.0	+42.9	-50.0
BU5	2	0	1.6	1.6	2	0	1	0	0	-	--37.5	-100.0
BU6	8	5	3.3	2.1	8	4	3	1.6	0	-20.0	-9.1	-23.8
BU11	3	2	1.6	0.9	4	2	2.1	0.5	+33.3	0	+31.3	-44.4
BU14	4	3	0.7	0.5	2	1	0.7	0.1	-50.0	-66.7	0	-80.0
BU19	6	3	1.8	1.2	8	2	2.8	0.7	+33.3	-33.3	+55.6	-41.7
BU20	2	2	1.5	1.5	9	6	2.7	2.2	+350.0	+200.0	+80.0	+46.7
BU21	1	0	0.2	0	2	0	0.6	0	+100.0	-	+200.0	-
BU22	3	1	0.3	0.1	2	1	1.1	0.1	-33.3	0	+266.7	0
BU23	0	0	0	0	1	0	0.4	0	0	-	-	-
BU24	4	2	1.4	0.4	4	1	1.2	0.1	0	-50.0	-14.3	-75
BU25	1	0	0.5	0	1	0	0.1	0	0	-	-80.0	-
BU26	6	0	1.7	0	3	0	0.9	0	-50.0	-	-47.1	-
BU27	7	3	1.7	0.5	9	2	2.1	0.4	+28.6	-33.3	+23.5	-20.0
Mean	3.8	1.6	1.3	0.7	4.2	1.4	1.5	0.5	29.1	-5.9	39.4	-38.8

On Mine Lease but Outside Development Areas

	September 2008				September 2009				% Change			
	Species Richness	Perennial /Biennial Richness	Total Cover	Perennial Cover	Species Richness	Perennial/B iennial Richness	Total Cover	Perennial Cover	Species Richness	Perennial/B iennial Richness	Total Cover	Perennial Cover
BU8	3	0	1.1	0	6	1	1.1	0.1	+100.0	-	0	-
BU9	8	5	5.1	4.6	8	5	2.6	2.1	0	0	-49.0	-54.3
BU10	8	5	2.3	1.0	5	2	1.8	0.5	-37.5	-60.0	-21.7	-50.0
BU15	8	5	2.1	2.1	6	3	1.8	1.2	-25.0	-40.0	-14.3	-42.9
BU18	7	4	5.4	4.4	6	4	4.6	3.2	-14.3	0	-14.8	-27.3
Mean	6.2	3.8	3.2	2.4	6.2	3.0	2.4	1.4	4.6	-25.0	-20.0	-43.6

Outside Mine Lease

	September 2007				September 2008				% Change			
	Species Richness	Perennial /Biennial Richness	Total Cover	Perennial Cover	Species Richness	Perennial /Biennial Richness	Total Cover	Perennia l Cover	Species Richness	Perennial /Biennial Richness	Total Cover	Perennial Cover
BU1	5	5	2.9	2.6	5	4	2.3	1.0	0	-20.0	-20.7	-61.5
BU2	1	1	0.6	2.6	2	0	1.1	0	+100.0	-100.0	+83.3	-100.0
BU3	6	2	1.9	0.6	15	3	7.6	0.6	+150.0	+50.0	+300.0	0
BU7	7	3	2.9	0.6	8	3	2.5	0.9	+14.3	0	-13.8	+50.0
BU12	4	0	1.3	1.5	6	0	2.5	0	+50.0	-	+92.3	-100.0
BU13A	3	1	0.3	0	6	1	1.2	0.1	+100.0	0	+300.0	-
BU13B	0	0	0	0.1	3	0	2.3	0	-	-	-	-100.0
BU16A	4	4	0.5	0	3	2	0.3	0.2	-25.0	-50.0	-40.0	-
BU16B	9	4	3.9	0.5	11	5	1.9	0.4	+22.2	+25.0	-51.3	-20.0
Mean	4.3	2.2	1.6	1.4	6.6	2.0	2.4	0.4	+51.4	-13.6	+81.2	-47.4

Probabilities (all sites)

(Students t-test for matched pairs)

	All Sites	Mine Development Areas	Mine Lease Outside Development	Pastoral Sites
Species Richness	NS	NS	NS	*
Perennial Richness	NS	NS	NS	NS
Total Cover	NS	NS	*	NS
Perennial Cover	**	*	*	NS

Significance: NS $p > 0.05$, * $0.05 > p > 0.01$, ** $0.01 > p > 0.001$, *** $0.001 > p$

APPENDIX A: CLEAN DATA AND INDIVIDUAL ANALYSIS SHEETS FOR SEPTEMBER 2009 QUADRAT DATA

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU1				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1	1	1	1	1	1	1	1	1	1	1.0	
Neobassia proceriflora	Biennial shrub/subshrub						1					0.1	
Sclerolaena brachyptera	Biennial shrub/subshrub							2		1		0.3	
Sclerolaena ventricosa	Biennial shrub/subshrub				1							0.1	
*Tribulus terrestris	Ephemeral/Annual	1	1	1	1			1	1	1	1	0.8	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.2	5
Perennials/biennials	1.4	4
Ephemerals	0.8	1
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.5	Biennial	0.5
Grass	1.0	Ephemeral/annual	0.8
Herb	0.8	All species	2.3
Shrubs & trees	0	All perennials	1.0
Grasses & herbs	1.8	Alien species	0.8

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU2				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
*Tribulus terrestris	Ephemeral/Annual	1	1	1		1	1		1		1	0.7					
Dactyloctenium radulans	Ephemeral/annual grass							1	1	1	1	0.4					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.1	2
Perennials/biennials	0	0
Ephemerals	1.1	2
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.4	Ephemeral/annual	1.1
Herb	0.7	All species	1.1
Shrubs & trees	0	All perennials	0
Grasses & herbs	1.1	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU3A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Maireana aphylla	Long-lived perennial shrub					1						0.1	0
Neobassia proceriflora	Biennial shrub/subshrub				1			1	1	1	1	0.5	
Atriplex holocarpa	Ephemeral/annual									1		0.1	
Calotis hispidula	Ephemeral/annual								1		1	0.2	
Chenopodium desertorum	Ephemeral/Annual							1	1	1	1	0.4	
Cullen sp.	Ephemeral/annual								1	1	1	0.3	
Euphorbia stevenii	Ephemeral/annual					1				1		0.2	
Lepidium phlebopetalum	Ephemeral/annual									1	1	0.2	
Plantago drummondii	Ephemeral/annual								1			0.1	
Portulaca sp.	Ephemeral/annual				1			1	1		1	0.4	
Trianthema triquetra	Ephemeral/annual	1		2		1	1	1	1			0.7	
Tribulus terrestris	Ephemeral/Annual	1	1	1		1	1	1				0.6	
Dactyloctenium radulans	Ephemeral/annual grass	1	1	1	1	2	1	2	1	15	5	3.0	
Sporobolus actinocladus	Ephemeral/annual grass									1	1	0.2	
Tripogon loliiformis	Ephemeral/annual grass		1	1	1	1	1		1			0.6	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	5.5	15
Perennials/biennials	0.6	3
Ephemerals	4.9	12
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.1
Shrub/subshrub	0.6	Biennial	0.5
Grass	3.8	Ephemeral/annual	7.0
Herb	7.0	All species	7.6
Shrubs & trees	0	All perennials	0.6
Grasses & herbs	7.0	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU4C				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass			1	1	1	1		1		1	0.6	
Boerhavia sp.	Ephemeral/annual	2	2	2								0.6	
Salsola kali	Ephemeral/annual	1	1	1			1				1	0.5	
*Tribulus terrestris	Ephemeral/annual		1	1	1							0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.7	4
Perennials/biennials	0.6	0.6
Ephemerals	1.1	1.4
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.6
Shrub/subshrub	0	Biennial	0
Grass	0.6	Ephemeral/annual	1.4
Herb	1.4	All species	2.0
Shrubs & trees	0	All perennials	0.6
Grasses & herbs	2.0	Alien species	0.3

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU5A				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
*Tribulus terrestris	Biennial shrub/subshrub		1		1	1	1	1	1	1	1	0.8		
Tripogon loliiformis	Ephemeral/annual grass		1		1							0.2		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.0	2
Perennials/biennials	0	0
Ephemerals	1.0	2
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.2	Ephemeral/annual	1.0
Herb	0.8	All species	1.0
Shrubs & trees	0	All perennials	0
Grasses & herbs	1.0	Alien species	0.8

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU6A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1		1				1		1	1	0.5	
Neobassia proceriflora	Biennial shrub/subshrub							1		1	1	0.3	
Sclerolaena ventricosa	Biennial shrub/subshrub		1	1	1	1	1	1		1		0.7	
Sida fibulifera	Biennial shrub/subshrub									1		0.1	
Atriplex holocarpa	Ephemeral/annual			1	1			1				0.3	
Boerhavia sp.	Ephemeral/annual	1			1		1	1				0.4	
Salsola kali	Ephemeral/annual			1	1		1		1	1	1	0.6	
*Tribulus terrestris	Ephemeral/annual				1							0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	3.0	8
Perennials/biennials	0.8	4
Ephemerals	1.4	4
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.5
Shrub/subshrub	0.3	Biennial	1.1
Grass	0.5	Ephemeral/annual	1.4
Herb	1.4	All species	3.0
Shrubs & trees	0	All perennials	1.6
Grasses & herbs	1.9	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU7				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1			1	1		1			1	0.5	
Neobassia proceriflora	Biennial shrub/subshrub	2								1	1	0.4	
Sida trichopoda	Biennial shrub/subshrub					1						0.1	
Atriplex holocarpa	Ephemeral/annual							1	1			0.2	
Cullen sp.	Ephemeral/annual			1						1		0.2	
Euphorbia stevenii	Ephemeral/annual		1			1						0.2	
Flaveria australasica	Ephemeral/annual			1				1		1		0.3	
*Tribulus terrestris	Ephemeral/annual			1	1	1	1	1	1		1	0.7	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.5	8
Perennials/biennials	0.9	3
Ephemerals	1.6	5
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.5
Shrub/subshrub	0.4	Biennial	0.4
Grass	0.5	Ephemeral/annual	1.4
Herb	1.6	All species	2.5
Shrubs & trees	0	All perennials	0.9
Grasses & herbs	2.1	Alien species	0.7

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU8A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Sclerolaena ventricosa	Biennial shrub/subshrub					1						0.1	
Salsola kali	Ephemeral/annual					1		2				0.3	
Trianthema triquetra	Ephemeral/annual					1					1	0.2	
Tribulus terrestris	Ephemeral/annual							1	1		1	0.3	
Dactyloctenium radulans	Ephemeral/annual grass									1		0.1	
Tripogon loliiformis	Ephemeral/annual grass			1								0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.0	6
Perennials/biennials	0.1	1
Ephemerals	0.9	5
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.1	Biennial	0.1
Grass	0.2	Ephemeral/annual	1.0
Herb	0.8	All species	1.1
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	1.0	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU9A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1	1	1	1	1	1	1	1	1	1	1.0	
Dissocarpus paradoxus	Biennial shrub/subshrub							1	1			0.2	
Neobassia proceriflora	Biennial shrub/subshrub		1	2							1	0.4	
Sclerolaena divaricata	Biennial shrub/subshrub				2		2					0.4	
Sclerolaena ventricosa	Biennial shrub/subshrub			1								0.1	
Arabidella nasturtium	Ephemeral/annual					1						0.1	
Atriplex holocarpa	Ephemeral/annual					1						0.1	
Salsola kali	Ephemeral/annual	1				1	1					0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.3	8
Perennials/biennials	1.5	5
Ephemerals	0.5	3
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	1.0
Shrub/subshrub	0.6	Biennial	1.1
Grass	1.0	Ephemeral/annual	0.5
Herb	0.5	All species	2.6
Shrubs & trees	0	All perennials	2.1
Grasses & herbs	1.5	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU10A				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Astrebla pectinata	Long-lived perennial grass									1	1	0.2		
Eremophila duttonii	Long-lived perennial shrub		1		1		1					0.3	2	
Salsola kali	Ephemeral/annual								1	1		0.2		
*Tribulus terrestris	Ephemeral/annual		1	1	1		1	2	1	2	1	1.0		
Dactyloctenium radulans	Ephemeral/annual grass				1							0.1		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.6	5
Perennials/biennials	0.5	2
Ephemerals	1.1	3
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		2

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	1	Long-lived perennial	0.5
Shrub/subshrub	0	Biennial	0
Grass	0.3	Ephemeral/annual	1.3
Herb	1.3	All species	1.8
Shrubs & trees	0.3	All perennials	0.5
Grasses & herbs	1.5	Alien species	1.0

BEVERLEY URANIUM PHOTOPPOINT QUADRAT					BU11					September 2009				
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Rhagodia spinescens	Long-lived perennial shrub		1		2						1	0.4	2	
Sclerolaena brachyptera	Biennial shrub/subshrub										1	0.1		
*Tribulus terrestris	Ephemeral/annual	1	1	1	1		2	1				0.7		
Dactyloctenium radulans	Ephemeral/annual grass	1	1	1	1	1	1	1	1		1	0.9		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.9	4
Perennials/biennials	0.4	2
Ephemerals	1.5	2
Alien species	0.6	1
Total Density Long-lived Perennial Shrubs		1

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.4
Shrub/subshrub	0.5	Biennial	0.1
Grass	0.9	Ephemeral/annual	1.6
Herb	0.7	All species	2.1
Shrubs & trees	0.4	All perennials	0.5
Grasses & herbs	1.6	Alien species	0.7

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU12A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Atriplex sp.	Ephemeral/annual	1	2	1	2	1	1	1		1		1.0	
Boerhavia sp.	Ephemeral/annual						1					0.1	
Salsola kali	Ephemeral/annual	1		1				1				0.3	
Portulaca sp.	Ephemeral/annual		1	1	1	1	1			1		0.6	
*Tribulus terrestris	Ephemeral/annual				1			1	1			0.3	
Dactyloctenium radulans	Ephemeral/annual grass					1		1				0.2	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.3	6
Perennials/biennials	0	0
Ephemerals	2.3	6
Alien species	0.3	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.2	Ephemeral/annual	2.5
Herb	2.5	All species	2.5
Shrubs & trees	0	All perennials	0
Grasses & herbs	2.5	Alien species	0.3

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU13A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Sclerolaena ventricosa	Biennial shrub/subshrub	1										0.1	
Chamaesyce drummondii	Ephemeral/annual					1						0.1	
Salsola kali	Ephemeral/annual			2								0.2	
Trianthema triquetra	Ephemeral/annual		1		1			1	1	1		0.5	
Dactyloctenium radulans	Ephemeral/annual grass			1			1					0.2	
Tripogon loliiformis	Ephemeral/annual grass								1			0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.1	6
Perennials/biennials	0.1	1
Ephemerals	1.0	5
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.1	Biennial	0.1
Grass	0.1	Ephemeral/annual	0.1
Herb	1.0	All species	1.2
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	1.1	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU13B				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Trianthema triquetra	Ephemeral/annual	1	1		1	1			1			0.5		
*Tribulus terrestris	Ephemeral/annual	1	1	1			1	1	1	1	1	0.8		
Dactyloctenium radulans	Ephemeral/annual grass	1	2	1	1	1	1	1	1		1	1.0		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.2	3
Perennials/biennials	0	0
Ephemerals	2.2	3
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	1.0	Ephemeral/annual	2.3
Herb	1.3	All species	2.3
Shrubs & trees	0	All perennials	0
Grasses & herbs	2.3	Alien species	0.8

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU14				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Astrebla pectinata	Long-lived perennial grass		1									0.1					
*Tribulus terrestris	Ephemeral/annual	1	1	1	1		1				1	0.6					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.7	2
Perennials/biennials	0.1	1
Ephemerals	0.6	1
Alien species	0.6	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.1
Shrub/subshrub	0	Biennial	0
Grass	0.1	Ephemeral/annual	0.6
Herb	0.6	All species	0.7
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	0.6	Alien species	0.6

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU15A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass				1			1	1	1	1	0.5	
Dissocarpus paradoxus	Biennial shrub/subshrub										1	0.1	
Sclerolaena divaricata	Biennial shrub/subshrub							5	1			0.6	
Atriplex sp.	Ephemeral/annual							1	1			0.2	
Salsola kali	Ephemeral/annual	1								1		0.2	
*Tribulus terrestris	Ephemeral/annual	1						1				0.2	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.4	6
Perennials/biennials	0.8	3
Ephemerals	0.6	3
Alien species	0.2	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.5
Shrub/subshrub	0.7	Biennial	0.7
Grass	0.5	Ephemeral/annual	0.6
Herb	0.6	All species	1.8
Shrubs & trees	0	All perennials	1.2
Grasses & herbs	1.1	Alien species	0.2

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU16A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1										0.1	
Neobassia proceriflora	Biennial shrub/subshrub		1									0.1	
*Tribulus terrestris	Ephemeral/annual		1									0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.3	3
Perennials/biennials	0.2	2
Ephemerals	0.1	1
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.1
Shrub/subshrub	0.1	Biennial	0.1
Grass	0.1	Ephemeral/annual	0.1
Herb	0.1	All species	0.3
Shrubs & trees	0	All perennials	0.2
Grasses & herbs	0.2	Alien species	0.1

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU16B				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1										0.1	
Neobassia proceriflora	Biennial shrub/subshrub	1										0.1	
Sclerolaena brachyptera	Biennial shrub/subshrub	1										0.1	
Sclerolaena ventricosa	Biennial shrub/subshrub	1										0.1	
Sida sp.	Biennial shrub/subshrub	1										0.1	
Cullen sp.	Ephemeral/annual	1	5									0.6	
Portulaca sp.	Ephemeral/annual		1									0.1	
Salsola kali	Ephemeral/annual		1									0.1	
Trianthema triquetra	Ephemeral/annual		1									0.1	
*Tribulus terrestris	Ephemeral/annual	1	1	1		1						0.4	
Dactyloctenium radulans	Ephemeral/annual grass		1									0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.5	11
Perennials/biennials	0.4	5
Ephemerals	1.1	6
Alien species	0.4	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.1
Shrub/subshrub	0.3	Biennial	0.3
Grass	0.2	Ephemeral/annual	1.4
Herb	1.4	All species	1.9
Shrubs & trees	0	All perennials	0.4
Grasses & herbs	1.5	Alien species	0.4

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU18B				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Sclerolaena divaricata	Biennial shrub/subshrub				1	1		1	5	2	2	1.2	
Sclerolaena lanicuspis	Biennial shrub/subshrub								1		1	0.2	
Sclerolaena longicuspis	Biennial shrub/subshrub	10	1	1		5					1	1.8	
Sclerolaena ventricosa	Biennial shrub/subshrub	1								1		0.2	
Boerhavia sp.	Ephemeral/annual						2	5	1	2	2	1.2	
*Tribulus terrestris	Ephemeral/annual					1			1			0.2	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.2	6
Perennials/biennials	1.5	4
Ephemerals	0.7	2
Alien species	0.2	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	3.2	Biennial	3.2
Grass	0	Ephemeral/annual	1.4
Herb	1.4	All species	4.6
Shrubs & trees	0	All perennials	3.2
Grasses & herbs	1.4	Alien species	0.2

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU19A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1		1	1	1					1	0.5	
Sclerolaena brachyptera	Biennial shrub/subshrub				2							0.2	
Boerhavia sp.	Ephemeral/annual			1								0.1	
Atriplex holocarpa	Ephemeral/annual			1	1		1					0.3	
Euphorbia stevenii	Ephemeral/annual					1				1		0.2	
Salsola kali	Ephemeral/annual			1	1	1	2		1			0.6	
*Tribulus terrestris	Ephemeral/annual	1	1	1	1		1	1	1	1		0.8	
Tripogon loliiformis	Ephemeral/annual grass			1								0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.6	8
Perennials/biennials	0.7	2
Ephemerals	2.0	6
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.5
Shrub/subshrub	0.2	Biennial	0.2
Grass	0.6	Ephemeral/annual	2.1
Herb	2.0	All species	2.8
Shrubs & trees	0	All perennials	0.7
Grasses & herbs	2.6	Alien species	0.8

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU20A				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	2	1	2	1		1	1		2	2	1.2	
Dissocarpus paradoxus	Biennial shrub/subshrub	1										0.1	
Neobassia proceriflora	Biennial shrub/subshrub	1		1		1			1	1	1	0.6	
Sclerolaena brachyptera	Biennial shrub/subshrub									1		0.1	
Sclerolaena ventricosa	Biennial shrub/subshrub		1									0.1	
Sida trichopoda	Biennial shrub/subshrub		1									0.1	
Atriplex holocarpa	Ephemeral/annual	1		1		1						0.3	
Euphorbia stevenii	Ephemeral/annual		1									0.1	
*Tribulus terrestris	Ephemeral/annual				1							0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.3	9
Perennials/biennials	1.8	6
Ephemerals	0.5	3
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	1.2
Shrub/subshrub	1.0	Biennial	1.0
Grass	1.2	Ephemeral/annual	0.5
Herb	0.5	All species	2.7
Shrubs & trees	0	All perennials	2.2
Grasses & herbs	1.7	Alien species	0.1

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU21				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Salsola kali	Ephemeral/annual								2	1	2	0.5	
*Tribulus terrestris	Ephemeral/annual							1				0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.4	2
Perennials/biennials	0	0
Ephemerals	0.4	2
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	0.6
Herb	0.6	All species	0.6
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.6	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU22				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Sclerolaena ventricosa	Biennial shrub/subshrub			1								0.1		
Salsola kali	Ephemeral/annual	2	1	2	1	1		1	1		1	1.0		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.9	2
Perennials/biennials	0.1	1
Ephemerals	0.8	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.1	Biennial	0.1
Grass	0	Ephemeral/annual	1.0
Herb	1.0	All species	1.1
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	1.0	Alien species	0

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU23				September 2009										
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density					
		1	2	3	4	5	6	7	8	9	10							
Salsola kali	Ephemeral/annual		1				1		1		1	0.4						

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.4	1
Perennials/biennials	0	0
Ephemerals	0.4	0.4
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	0.4
Herb	0.4	All species	0.4
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.4	Alien species	0

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU24				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Sclerolaena brachyptera	Biennial shrub/subshrub	1										0.1	
Atriplex holocarpa	Ephemeral/annual						1					0.1	
Salsola kali	Ephemeral/annual	1	1	1				1	1	1		0.6	
*Tribulus terrestris	Ephemeral/annual	1	1			1					1	0.4	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.2	4
Perennials/biennials	0.1	1
Ephemerals	1.1	3
Alien species	0.4	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.1	Biennial	0.1
Grass	0	Ephemeral/annual	1.1
Herb	1.1	All species	1.2
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	1.1	Alien species	0.4

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU25				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Tripogon loliiformis	Ephemeral/annual grass							1				0.1					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.1	1
Perennials/biennials	0	0
Ephemerals	0.1	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.1	Ephemeral/annual	0.1
Herb	0	All species	0.1
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.1	Alien species	0

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BU26				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Solanum ellipticum	Ephemeral/annual				1		1					0.2		
Dactyloctenium radulans	Ephemeral/annual grass									1		0.1		
Tripogon loliiformis	Ephemeral/annual grass	1		1	1	1			1	1		0.6		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.9	3
Perennials/biennials	0	0
Ephemerals	0.9	3
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.7	Ephemeral/annual	0.9
Herb	0.2	All species	0.9
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.9	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BU27				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Eriochiton sclerolaenoides	Biennial shrub/subshrub						1		1		1	0.3	
Sclerolaena ventricosa	Biennial shrub/subshrub	1										0.1	
Boerhavia sp.	Ephemeral/annual		1									0.1	
Salsola kali	Ephemeral/annual	1										0.1	
*Tribulus terrestris	Ephemeral/annual						1					0.1	
Dactyloctenium radulans	Ephemeral/annual grass	1	1	1		1						0.4	
Enneapogon avenaceus	Ephemeral/annual grass			1	1				1		1	0.4	
Sporobolus actinocladus	Ephemeral/annual grass		1	1						1		0.3	
Tripogon loliiformis	Ephemeral/annual grass	1				1			1			0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.1	9
Perennials/biennials	0.4	2
Ephemerals	1.7	7
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.4	Biennial	0.4
Grass	1.4	Ephemeral/annual	1.7
Herb	0.3	All species	2.1
Shrubs & trees	0	All perennials	0.4
Grasses & herbs	1.7	Alien species	0.1

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BE01				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Rhagodia spinescens	Long-lived perennial shrub						75	1	90			16.6					
Enteropogon ramosus	Long-lived perennial grass	1	1		1	1						0.4					
Rhyncharrhena linearis	Long-lived perennial vine								1			0.1					
Sclerolaena diacantha	Biennial shrub/subshrub		1									0.1					
Sclerolaena ventricosa	Biennial shrub/subshrub			1		1		1				0.3					
Salsola kali	Ephemeral/annual			1								0.1					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.3	6
Perennials/biennials	1.2	5
Ephemerals	0.1	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	17.1
Shrub/subshrub	17.5	Biennial	0.4
Grass	0.4	Ephemeral/annual	0.1
Herb	0.1	All species	17.6
Shrubs & trees	0	All perennials	17.5
Grasses & herbs	0.5	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE02				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Boerhavia sp.	Ephemeral/annual			1		1	1		1		1	0.5		
Salsola kali	Ephemeral/annual	1		10					1		5	1.7		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.9	2
Perennials/biennials	0	0
Ephemerals	0.9	2
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	2.2
Herb	2.2	All species	2.2
Shrubs & trees	0	All perennials	0
Grasses & herbs	2.2	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE03		September 2009								
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Enteropogon ramosus	Long-lived perennial grass				1						1	0.2		
Boerhavia sp.	Ephemeral/annual	2	2	1	2	1	2	1		2	5	1.8		
*Brassica tournefortii	Ephemeral/annual			1								0.1		
Salsola kali	Ephemeral/annual						2		5			0.7		
Enneapogon avenaceus	Ephemeral/annual grass					1						0.1		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.5	5
Perennials/biennials	0.2	1
Ephemerals	1.3	4
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.2
Shrub/subshrub	0	Biennial	0
Grass	0.3	Ephemeral/annual	2.7
Herb	2.6	All species	2.9
Shrubs & trees	0	All perennials	0.2
Grasses & herbs	2.9	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE04				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Portulaca sp.	Ephemeral/annual					1			1			0.2					
*Tribulus terrestris	Ephemeral/annual		1		1							0.2					
Tripogon loliiformis	Ephemeral/annual grass							1				0.1					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.5	3
Perennials/biennials	0	0
Ephemerals	0.5	3
Alien species	0.2	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.1	Ephemeral/annual	0.5
Herb	0.5	All species	0.5
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.5	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE05				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Chenopodium desertorum	Ephemeral/annual									1		0.1	
*Tribulus terrestris	Ephemeral/annual		5		1		1	2	1	1	1	1.2	
Enneapogon avenaceus	Ephemeral/annual grass			1		1		1				0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.1	3
Perennials/biennials	0	0
Ephemerals	1.1	3
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.3	Ephemeral/annual	1.6
Herb	1.3	All species	1.6
Shrubs & trees	0	All perennials	0
Grasses & herbs	1.6	Alien species	1.2

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE06				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass						1		1		1	0.3	
*Tribulus terrestris	Ephemeral/annual	1	1	1	1	1		1		1		0.7	
Dactyloctenium radulans	Ephemeral/annual grass				1	1			1			0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.3	3
Perennials/biennials	0.3	1
Ephemerals	1.0	2
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.3
Shrub/subshrub	0	Biennial	0
Grass	0.6	Ephemeral/annual	1.0
Herb	0.7	All species	1.3
Shrubs & trees	0	All perennials	0.3
Grasses & herbs	1.3	Alien species	0.7

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE07				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Neobassia proceriflora	Biennial shrub/subshrub								1			0.1		
Portulaca sp.	Ephemeral/annual				1							0.1		
Trianthema triquetra	Ephemeral/annual					1	1			1	1	0.4		
*Tribulus terrestris	Ephemeral/annual									1		0.1		
Dactyloctenium radulans	Ephemeral/annual grass				1				1			0.2		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.9	5
Perennials/biennials	0.1	1
Ephemerals	0.8	4
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.1	Biennial	0.1
Grass	0.2	Ephemeral/annual	0.8
Herb	0.6	All species	0.9
Shrubs & trees	0	All perennials	0.1
Grasses & herbs	0.8	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE08				September 2009									
Species	Lifespan and Growth Form			% Cover in cells 1-10										Total Cover	Total Density		
				1	2	3	4	5	6	7	8	9	10				
Nil																	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0	0
Perennials/biennials	0	0
Ephemerals	0	0
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	0
Herb	0	All species	0
Shrubs & trees	0	All perennials	0
Grasses & herbs		0	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE09				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Eragrostis australasica	Long-lived perennial grass							1	1		1	0.3		
Rhagodia spinescens	Long-lived perennial shrub			1	1	40	30		5	1		7.8	4	
Sclerolaena divaricata	Biennial shrub/subshrub								2			0.2		
Sclerolaena ventricosa	Biennial shrub/subshrub		1	1		1						0.3		
Goodenia pinnatifida	Ephemeral/annual					1						0.1		
*Tribulus terrestris	Ephemeral/annual	1		1	1	1	1	1		1	1	0.8		
Dactyloctenium radulans	Ephemeral/annual grass	1	1		1					1		0.4		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.6	7
Perennials/biennials	1.0	4
Ephemerals	1.6	3
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		4

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	8.1
Shrub/subshrub	8.3	Biennial	0.5
Grass	0.7	Ephemeral/annual	1.3
Herb	0.9	All species	9.9
Shrubs & trees	0	All perennials	8.6
Grasses & herbs	1.6	Alien species	0.8

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE10				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Trianthema triquetra	Ephemeral/annual		1									0.1					
*Tribulus terrestris	Ephemeral/annual	1	1	1	1	1			1		1	0.7					
Tripogon loliiformis	Ephemeral/annual grass								1	1		0.2					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.0	3
Perennials/biennials	0	0
Ephemerals	1.0	3
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.2	Ephemeral/annual	1.0
Herb	0.8	All species	1.0
Shrubs & trees	0	All perennials	0
Grasses & herbs	1.0	Alien species	0.7

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE11				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Hakea leucoptera	Long-lived perennial tree						1	50	25	80	25	18.1					
Maireana aphylla	Long-lived perennial shrub						5		1			0.6					
Rhagodia spinescens	Long-lived perennial shrub							2	1	1	5	0.9					
Enteropogon ramosus	Long-lived perennial grass							5		2	1	0.8					
Ptilotus obovatus	Biennial shrub/subshrub									1		0.1					
Sclerolaena ventricosa	Biennial shrub/subshrub							1	5			0.6					
Malvastrum americanum	Ephemeral/annual							2				0.2					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.8	7
Perennials/biennials	1.7	6
Ephemerals	0.1	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	18.1	Long-lived perennial	20.4
Shrub/subshrub	2.2	Biennial	0.7
Grass	0.8	Ephemeral/annual	0.2
Herb	0.2	All species	21.3
Shrubs & trees	20.3	All perennials	21.1
Grasses & herbs	1.0	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE12				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Acacia tetragonophylla	Long-lived perennial shrub		1		60		40		10		1	11.2	1
Eremophila freelingii	Long-lived perennial shrub							5		15		2.0	1
Rhagodia spinescens	Long-lived perennial shrub										5	0.5	
Dissocarpus paradoxus	Biennial shrub/subshrub										1	0.1	
Ptilotus obovatus	Biennial shrub/subshrub		5		5				5			1.5	
Sclerolaena longicuspis	Biennial shrub/subshrub	1	1									0.2	
Dactyloctenium radulans	Ephemeral/annual grass				1				1			0.2	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.6	7
Perennials/biennials	1.4	6
Ephemerals	0.2	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		2

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	13.2	Long-lived perennial	13.7
Shrub/subshrub	1.3	Biennial	1.8
Grass	0.2	Ephemeral/annual	0.2
Herb	0	All species	15.7
Shrubs & trees	14.5	All perennials	15.5
Grasses & herbs	0.2	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE13				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Eremophila duttonii	Long-lived perennial shrub										1	0.1	1
Eremophila freelingii	Long-lived perennial shrub							25		1		2.6	
Senna artemisioides petiolaris	Long-lived perennial shrub			5								0.5	
Atriplex holocarpa	Ephemeral/annual				1							0.1	
Portulaca sp.	Ephemeral/annual				1							0.1	
Trianthema triquetra	Ephemeral/annual	1		1	1	1	1		1		1	0.7	
*Tribulus terrestris	Ephemeral/annual							1		1		0.2	
Dactyloctenium radulans	Ephemeral/annual grass			1	2	2	1	1	1		1	0.9	
Sporobolus actinocladus	Ephemeral/annual grass	1			1							0.2	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.4	9
Perennials/biennials	0.4	3
Ephemerals	2.0	6
Alien species	0	1
Total Density Long-lived Perennial Shrubs		1

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	3.2	Long-lived perennial	3.2
Shrub/subshrub	0	Biennial	0
Grass	1.1	Ephemeral/annual	2.2
Herb	1.1	All species	5.4
Shrubs & trees	3.2	All perennials	3.2
Grasses & herbs	2.2	Alien species	0.2

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE14		September 2009								
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Astrebla pectinata	Long-lived perennial grass					1		1	1			0.3		
Rhagodia spinescens	Long-lived perennial shrub			70		90		10	1			17.1	1	
Portulaca sp.	Ephemeral/annual							1				0.1		
Dactyloctenium radulans	Ephemeral/annual grass	1					1					0.2		
Tripogon loliiformis	Ephemeral/annual grass		1									0.1		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.1	5
Perennials/biennials	0.7	2
Ephemerals	0.4	3
Alien species	0	0
Total Density Long-lived Perennial Shrubs		1

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	17.4
Shrub/subshrub	17.1	Biennial	0
Grass	0.6	Ephemeral/annual	0.4
Herb	0.1	All species	17.8
Shrubs & trees	17.1	All perennials	17.4
Grasses & herbs	0.7	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE15				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Rhagodia spinescens	Long-lived perennial shrub	25	15									4.0	1
Portulaca sp.	Ephemeral/annual						1		1			0.2	
*Tribulus terrestris	Ephemeral/annual		1	1	1	1	1	1			1	0.7	
Dactyloctenium radulans	Ephemeral/annual grass				1		1		1			0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.4	4
Perennials/biennials	0.2	1
Ephemerals	1.2	3
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		1

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	4.0
Shrub/subshrub	4.0	Biennial	0
Grass	0.3	Ephemeral/annual	1.0
Herb	0.9	All species	5.2
Shrubs & trees	4.0	All perennials	4.0
Grasses & herbs		Alien species	0.7

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE16				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Sclerolaena intricata	Biennial shrub/subshrub									2		0.2	
Sida fibulifera	Biennial shrub/subshrub						1				1	0.2	
Atriplex holocarpa	Ephemeral/annual						1		1			0.2	
Euphorbia stevenii	Ephemeral/annual		1			2	1				1	0.5	
Flaveria australasica	Ephemeral/annual						1			1		0.2	
Lepidium phlebopetalum	Ephemeral/annual									1		0.1	
Salsola kali	Ephemeral/annual		1								1	0.2	
Trianthema triquetra	Ephemeral/annual									1	1	0.2	
*Tribulus terrestris	Ephemeral/annual	1	1			1						0.3	
Dactyloctenium radulans	Ephemeral/annual grass					1	1			1	1	0.4	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.3	10
Perennials/biennials	0.3	2
Ephemerals	2.0	8
Alien species	0.3	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0.4	Biennial	0.4
Grass	0.4	Ephemeral/annual	0.4
Herb	1.7	All species	2.5
Shrubs & trees	0	All perennials	0.4
Grasses & herbs	2.1	Alien species	0.3

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE17				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Neobassia proceriflora	Biennial shrub/subshrub	1	1	1	1	1	1		1		1	0.8	
Sclerolaena divaricata	Biennial shrub/subshrub		1				1					0.2	
Sida fibulifera	Biennial shrub/subshrub						1	1	1	1	1	0.5	
Calotis hispidula	Ephemeral/annual	1				1						0.2	
Cullen sp.	Ephemeral/annual		1		1	1			1			0.4	
Euphorbia stevenii	Ephemeral/annual		1	1	1	1	1			1		0.6	
*Tribulus terrestris	Ephemeral/annual							1				0.1	
Vittadinia sp.	Ephemeral/annual							1				0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.9	8
Perennials/biennials	1.5	3
Ephemerals	1.4	5
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	1.5	Biennial	1.5
Grass	0	Ephemeral/annual	2.9
Herb	1.4	All species	4.4
Shrubs & trees	0	All perennials	1.5
Grasses & herbs	1.4	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE18				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass			1		1						0.2	
Malacocera albolanata	Biennial shrub/subshrub				1							0.1	
Sclerolaena divaricata	Biennial shrub/subshrub			10	2	1	1			1		1.5	
Sclerolaena ventricosa	Biennial shrub/subshrub									1	1	0.2	
Boerhavia sp.	Ephemeral/annual									1		0.1	
Calotis hispidula	Ephemeral/annual									1		0.1	
Trianthema triquetra	Ephemeral/annual								1	1	2	0.4	
Salsola kali	Ephemeral/annual			1	1							0.2	
*Tribulus terrestris	Ephemeral/annual			1			1		1		2	0.5	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.1	9
Perennials/biennials	1.0	4
Ephemerals	1.1	5
Alien species	0.4	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	09	Long-lived perennial	0.2
Shrub/subshrub	0.8	Biennial	0.8
Grass	0.2	Ephemeral/annual	1.3
Herb	1.3	All species	2.3
Shrubs & trees	0	All perennials	1.0
Grasses & herbs	1.5	Alien species	0.5

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE19				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Astrebla pectinata	Long-lived perennial grass	1	1	1	1	1	1	1				0.7		
Sclerolaena brachyptera	Biennial shrub/subshrub			1		1		1		1		0.4		
Sclerolaena ventricosa	Biennial shrub/subshrub						1			1	1	0.3		
Sida fibulifera	Biennial shrub/subshrub						1					0.1		
Lepidium phlebopetalum	Ephemeral/annual			1								0.1		
Trianthema triquetra	Ephemeral/annual	1					1			1		0.3		
*Tribulus terrestris	Ephemeral/annual				1							0.1		
Dactyloctenium radulans	Ephemeral/annual grass	1	1					1			1	0.4		
Sporobolus actinocladus	Ephemeral/annual grass			1						1		0.2		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.6	9
Perennials/biennials	1.5	4
Ephemerals	1.1	5
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.7
Shrub/subshrub	0.8	Biennial	0.8
Grass	1.3	Ephemeral/annual	1.1
Herb	0.5	All species	2.6
Shrubs & trees	0	All perennials	1.5
Grasses & herbs	1.8	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE20				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Portulaca sp.	Ephemeral/annual		1				1					0.2	
Salsola kali	Ephemeral/annual							1				0.1	
*Tribulus terrestris	Ephemeral/annual	1	1	1	1	1	1	1		1		0.8	
Tripogon loliiformis	Ephemeral/annual grass				1	1	1	1	1	1	1	0.7	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.8	4
Perennials/biennials	0	0
Ephemerals	1.8	4
Alien species	0.8	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.7	Ephemeral/annual	1.8
Herb	1.1	All species	1.8
Shrubs & trees	0	All perennials	0
Grasses & herbs	1.8	Alien species	1.8

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE21				September 2009											
Species		Lifespan and Growth Form		% Cover in cells 1-10										Total Cover	Total Density				
				1	2	3	4	5	6	7	8	9	10						
Trianthema triquetra		Ephemeral/annual			1									0.1					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.1	1
Perennials/biennials	0	0
Ephemerals	0.1	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	0.1
Herb	0.1	All species	0.1
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.1	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE22				September 2009											
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density						
		1	2	3	4	5	6	7	8	9	10								
Tripogon loliiformis	Ephemeral/annual grass			1			1		1	1	1	0.5							

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.5	1
Perennials/biennials	0	0
Ephemerals	0.5	1
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.1	Ephemeral/annual	0.1
Herb	0	All species	0.1
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.1	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE23				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1		1					1	1		0.4	
Neobassia proceriflora	Biennial shrub/subshrub						1					0.1	
Sclerolaena divaricata	Biennial shrub/subshrub	1										0.1	
Euphorbia stevenii	Annual/ephemeral								1			0.1	
Salsola kali	Annual/ephemeral						1	1				0.2	
*Tribulus terrestris	Annual/ephemeral						1					0.1	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.0	6
Perennials/biennials	0.6	3
Ephemerals	0.4	3
Alien species	0.1	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.4
Shrub/subshrub	0.2	Biennial	0.2
Grass	0.4	Ephemeral/annual	0.4
Herb	0.4	All species	1.0
Shrubs & trees	0	All perennials	0.6
Grasses & herbs	0.8	Alien species	0.1

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE24				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Astrebla pectinata	Long-lived perennial grass				1		1			1		0.3		
Neobassia proceriflora	Biennial shrub/subshrub						1					0.1		
Sclerolaena divaricata	Biennial shrub/subshrub			5	1	1		1				0.8		
Sclerolaena brachyptera	Biennial shrub/subshrub						2					0.2		
Sida fibulifera	Biennial shrub/subshrub						1					0.1		
Sclerolaena ventricosa	Biennial shrub/subshrub		1									0.1		
Cullen sp.	Ephemeral/annual						1			1		0.2		
Euphorbia stevenii	Ephemeral/annual		1		1		1					0.3		
Rhodanthe stricta	Ephemeral/annual	1										0.1		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.7	9
Perennials/biennials	1.1	6
Ephemerals	0.6	3
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.3
Shrub/subshrub	1.3	Biennial	1.3
Grass	0.3	Ephemeral/annual	0.6
Herb	0.6	All species	2.2
Shrubs & trees	0	All perennials	1.6
Grasses & herbs	0.9	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE25				September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density				
		1	2	3	4	5	6	7	8	9	10						
Portulaca sp.	Ephemeral/annual		1	1		1	2	5		1		1.1					
*Tribulus terrestris	Ephemeral/annual		1	1	1		2	1	1		1	0.8					
Dactyloctenium radulans	Ephemeral/annual grass								1			0.1					

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	1.4	3
Perennials/biennials	0	0
Ephemerals	1.4	3
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0.1	Ephemeral/annual	2.0
Herb	1.9	All species	2.0
Shrubs & trees	0	All perennials	0
Grasses & herbs	2.0	Alien species	0.8

BEVERLEY URANIUM PHOTOPPOINT QUADRAT				BE26		September 2009								
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Astrebla pectinata	Long-lived perennial grass	1										0.1		
Eragrostis setifolia	Long-lived perennial grass	5	5		1							1.1		
Maireana aphylla	Long-lived perennial shrub				1		20	1				2.2		
Sclerolaena divaricata	Biennial shrub/subshrub	5		1	1						5	1.4		
Sclerolaena lanicuspis	Biennial shrub/subshrub			1								0.1		
Sclerolaena ventricosa	Biennial shrub/subshrub				1							0.1		
Atriplex holocarpa	Ephemeral/annual			1		1						0.2		
Atriplex limbata	Ephemeral/annual		1									0.1		
Chamaesyce drummondii	Ephemeral/annual			1								0.1		
Leiocarpa leptolepis	Ephemeral/annual				1							0.1		
*Tribulus terrestris	Ephemeral/annual	1		5	1	5	1	5	5	5	10	3.8		
Dactyloctenium radulans	Ephemeral/annual grass		1	1					2			0.4		
Tripogon loliiformis	Ephemeral/annual grass	1	1			1						0.3		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	3.3	13
Perennials/biennials	1.3	6
Ephemerals	2.0	7
Alien species	0.9	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	3.4
Shrub/subshrub	2.6	Biennial	1.6
Grass	1.9	Ephemeral/annual	5.0
Herb	4.3	All species	9.0
Shrubs & trees	2.2	All perennials	5.0
Grasses & herbs	6.2	Alien species	3.8

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE27				September 2009						
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density	
		1	2	3	4	5	6	7	8	9	10			
Eragrostis setifolia	Long-lived perennial grass				1					2		0.3		
Maireana aphylla	Long-lived perennial shrub			5					1	1	1	0.8		
Malacocera albolanata	Biennial shrub/subshrub		1		1	1		1	1	1		0.6		
Neobassia proceriflora	Biennial shrub/subshrub					1	1		1	1		0.4		
Sclerolaena ventricosa	Biennial shrub/subshrub	1	2			1	1	1			1	0.7		
Bulbine alata	Ephemeral/annual		1									0.1		
Cullen sp.	Ephemeral/annual						1					0.1		
Trianthema triquetra	Ephemeral/annual							1				0.1		
Dactyloctenium radulans	Ephemeral/annual grass	15	10	35	5	15	10	10	15	20	15	15.0		

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	3.5	9
Perennials/biennials	2.2	5
Ephemerals	1.3	4
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	1.1
Shrub/subshrub	2.5	Biennial	1.7
Grass	15.3	Ephemeral/annual	15.3
Herb	0.3	All species	18.1
Shrubs & trees	0.8	All perennials	2.8
Grasses & herbs	15.6	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE28				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass			1				1			1	0.3	
Neobassia proceriflora	Biennial shrub/subshrub	15	15	2	2	5	1	1				4.1	
Sclerolaena divaricata	Biennial shrub/subshrub		5	2							1	0.8	
Sida fibulifera	Biennial shrub/subshrub	2	2	1	1	1						0.7	
Euphorbia stevenii	Ephemeral/annual	1		1	2	1				1	2	0.8	
Salsola kali	Ephemeral/annual		2							1		0.3	
Trianthema triquetra	Ephemeral/annual								1			0.1	
*Tribulus terrestris	Ephemeral/annual		1	5		5	2	1	1	1		1.6	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	3.4	8
Perennials/biennials	1.8	4
Ephemerals	1.6	5
Alien species	0.7	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0.3
Shrub/subshrub	5.6	Biennial	5.6
Grass	0.3	Ephemeral/annual	2.8
Herb	2.8	All species	8.7
Shrubs & trees	0	All perennials	5.9
Grasses & herbs	3.1	Alien species	1.6

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE29		September 2009									
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density		
		1	2	3	4	5	6	7	8	9	10				
Rhagodia spinescens	Perennial shrub	60	30	10								10.0			
Sclerolaena divaricata	Biennial shrub/subshrub	1	1	2	10	2	1			1	2	2.0			
Portulaca sp.	Ephemeral/annual								1	1	1	0.3			
Tribulus eichlerianus	Ephemeral/annual	1	1	1	1	1	1	5	2	5	1	1.9			
Trianthema triquetra	Ephemeral/annual				1							0.1			
Dactyloctenium radulans	Ephemeral/annual grass						1		2		1	0.4			

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.8	6
Perennials/biennials	1.1	2
Ephemerals	1.7	4
Alien species	0	0
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	10.0
Shrub/subshrub	12.0	Biennial	2.0
Grass	0.4	Ephemeral/annual	2.7
Herb	2.3	All species	14.7
Shrubs & trees	10.0	All perennials	12.0
Grasses & herbs	2.7	Alien species	0

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE30				September 2009							
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density		
		1	2	3	4	5	6	7	8	9	10				
Astrebla pectinata	Long-lived perennial grass	1	1	2	1	2	1	1	1	1	2	1.3			
Neobassia proceriflora	Biennial shrub/subshrub		1	1	1	1	1	1	1	1	1	0.9			
Salsola kali	Annual/ephemeral		1									0.1			
Trianthema triquetra	Annual/ephemeral							1		2		0.3			
*Tribulus terrestris	Annual/ephemeral			1					1		1	0.3			
Vittadinia sp.	Annual/ephemeral									1	1	0.2			

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.7	6
Perennials/biennials	1.9	2
Ephemerals	0.8	4
Alien species	0.3	1
Total Density Long-lived Perennial Shrubs		0

COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	1.3
Shrub/subshrub	0.9	Biennial	0.9
Grass	1.3	Ephemeral/annual	0.9
Herb	0.9	All species	3.1
Shrubs & trees	0	All perennials	0
Grasses & herbs	2.2	Alien species	0.3

BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE31				September 2009					
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density
		1	2	3	4	5	6	7	8	9	10		
Astrebla pectinata	Long-lived perennial grass	1	5	5	2	1	1	1	1	1	2	2.0	
Neobassia proceriflora	Biennial shrub/subshrub	2		1								0.3	
Sclerolaena ventricosa	Biennial shrub/subshrub			1								0.1	
Euphorbia stevenii	Annual/Ephemeral	1										0.1	
Salsola kali	Annual/Ephemeral	2	1		1							0.4	
*Tribulus terrestris	Annual/Ephemeral		1	1	1							0.3	

SPECIES RICHNESS		
	1 sq m	10 sq m
All species	2.0	6
Perennials/biennials	1.4	3
Ephemerals	0.6	3
Alien species	0.3	1
Total Density Long-lived Perennial Shrubs		0

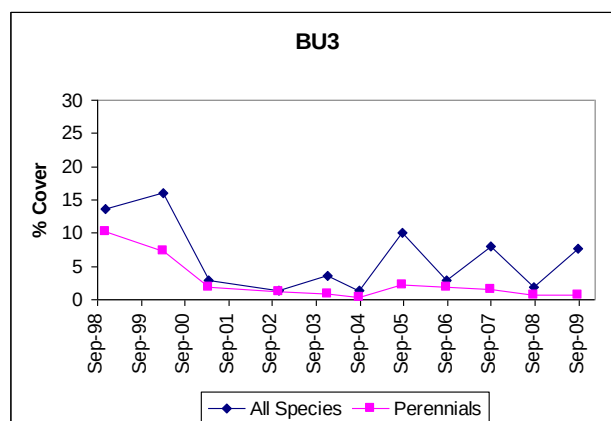
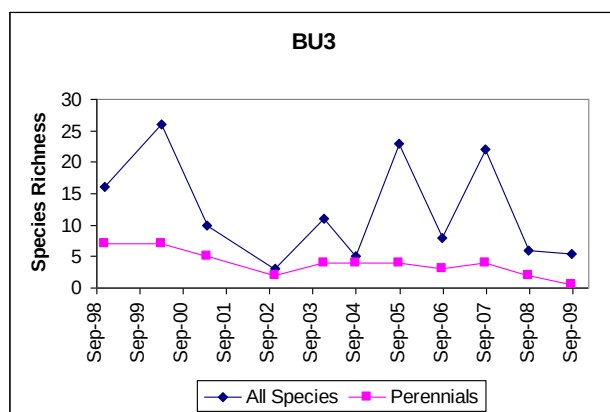
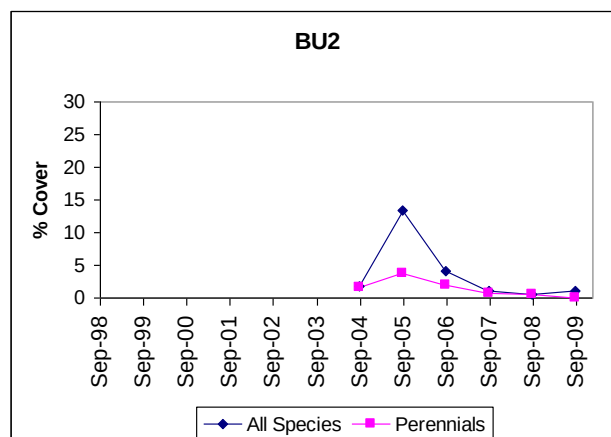
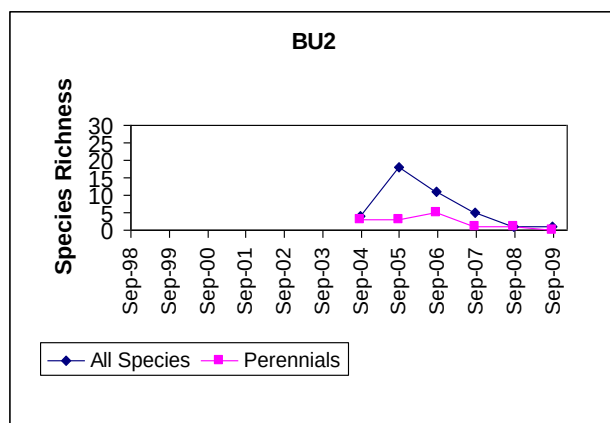
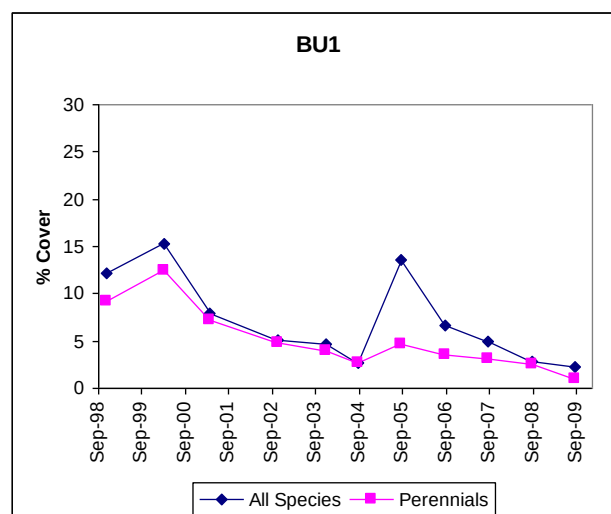
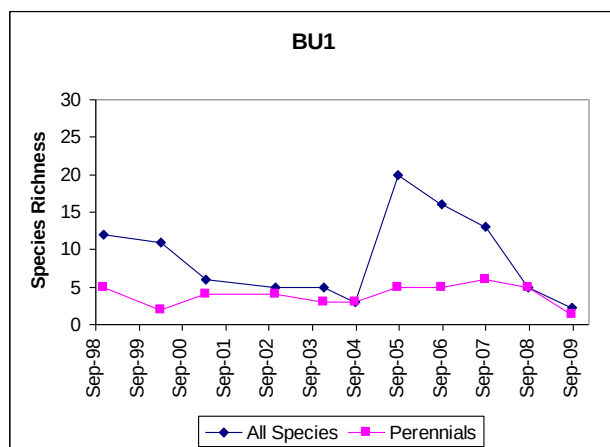
COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	2.0
Shrub/subshrub	0.4	Biennial	0.4
Grass	2.0	Ephemeral/annual	0.8
Herb	0.8	All species	3.2
Shrubs & trees	0	All perennials	2.4
Grasses & herbs	2.8	Alien species	0.3

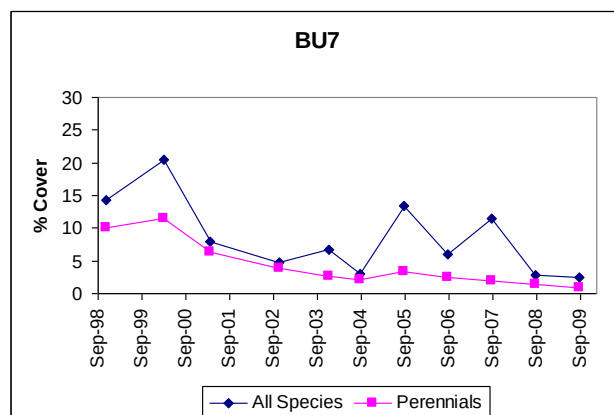
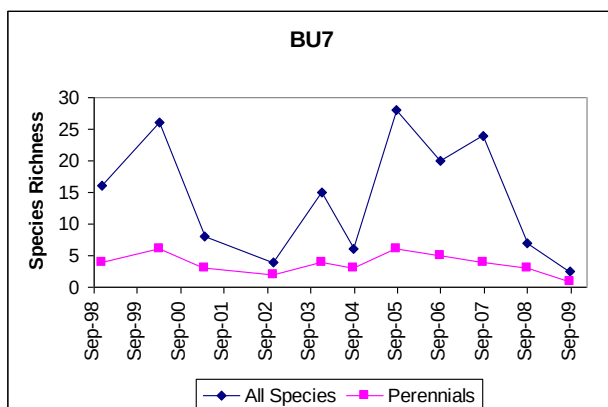
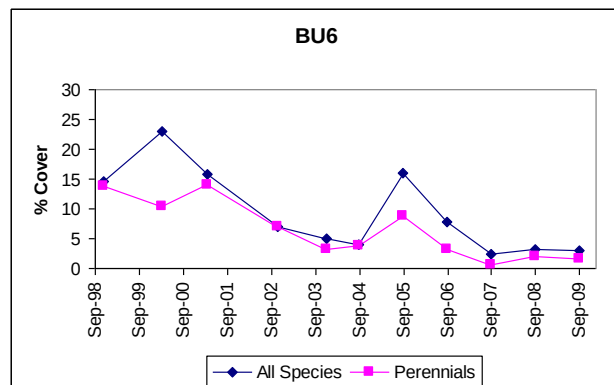
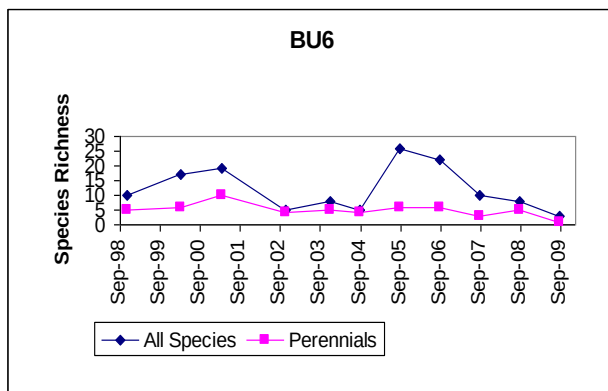
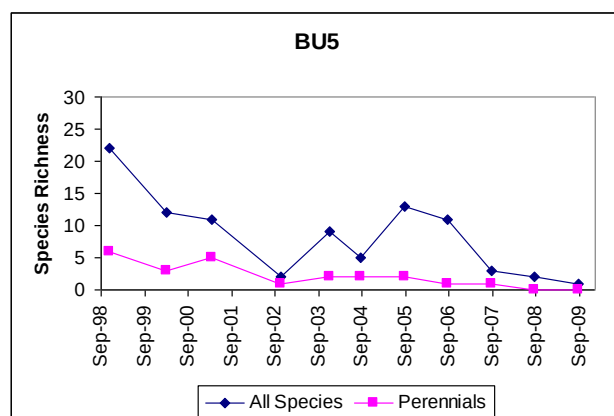
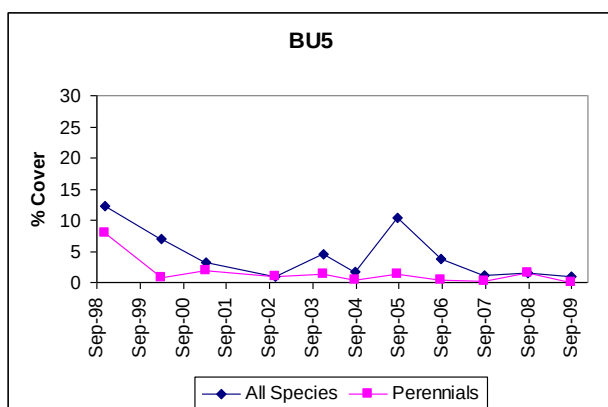
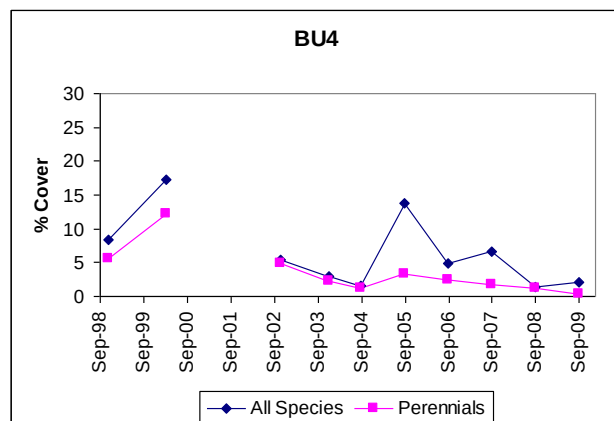
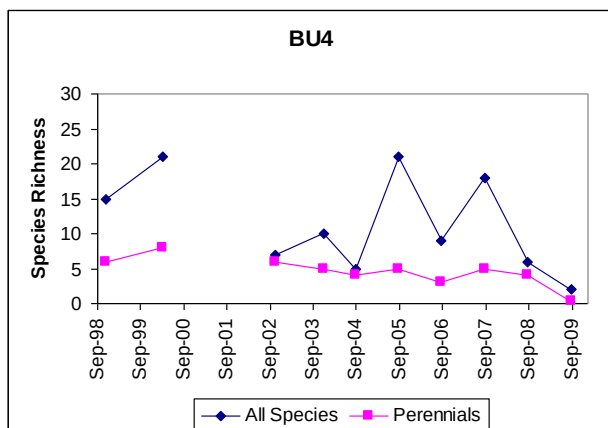
BEVERLEY URANIUM PHOTOPOINT QUADRAT				BE32				September 2009											
Species	Lifespan and Growth Form	% Cover in cells 1-10										Total Cover	Total Density						
		1	2	3	4	5	6	7	8	9	10								
Boerhavia sp.	Annual/Ephemeral						1	1		1		0.3							
*Tribulus terrestris	Annual/Ephemeral	1					1					0.2							

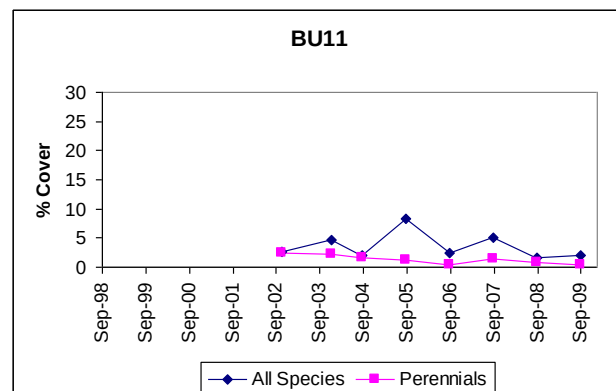
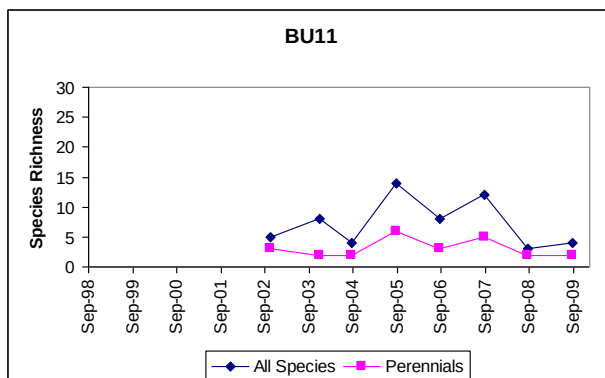
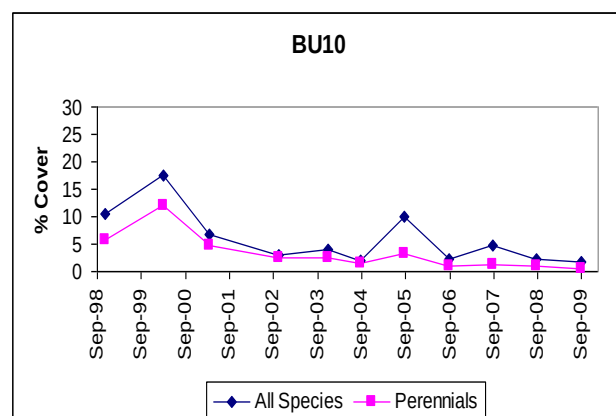
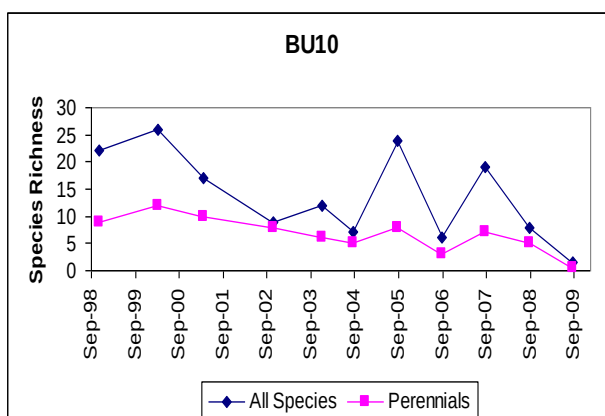
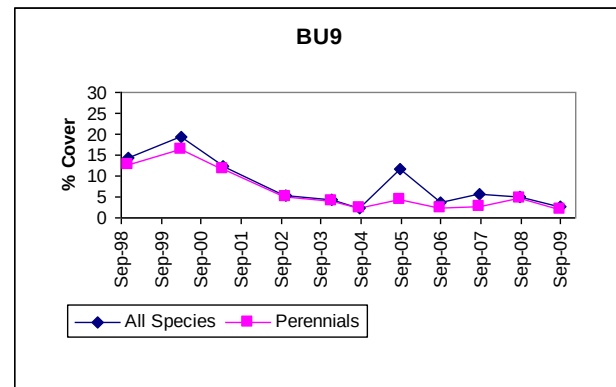
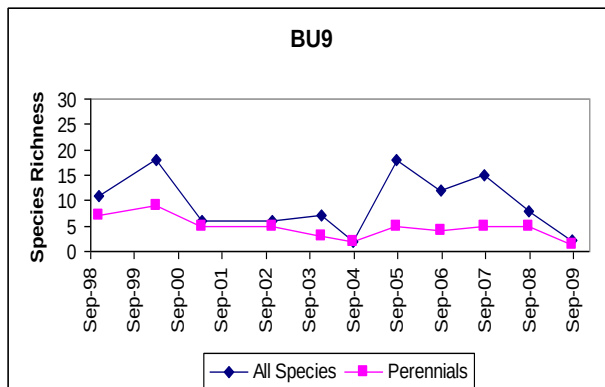
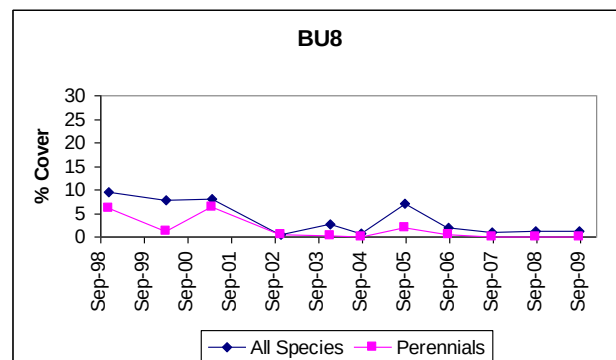
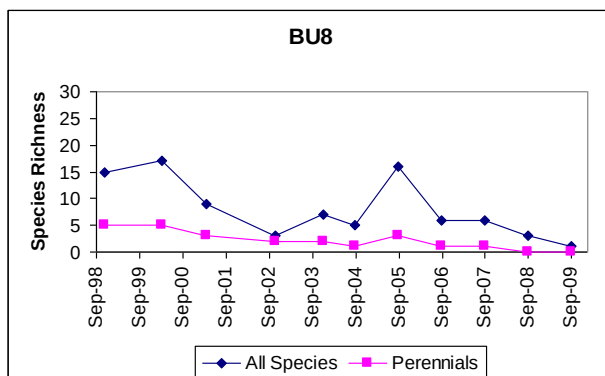
SPECIES RICHNESS		
	1 sq m	10 sq m
All species	0.5	2
Perennials/biennials	0	0
Ephemerals	0.5	2
Alien species	0.2	1
Total Density Long-lived Perennial Shrubs		0

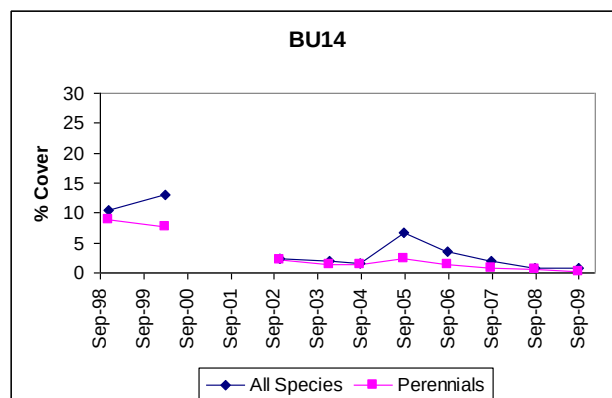
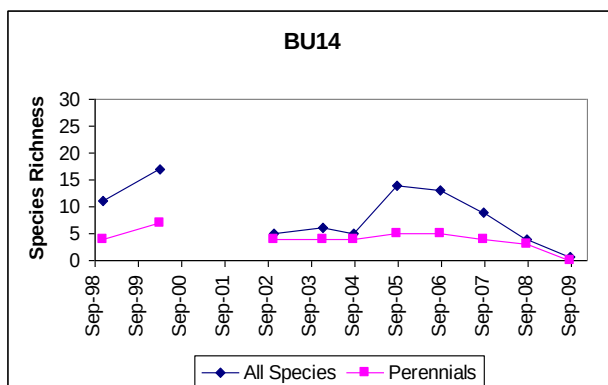
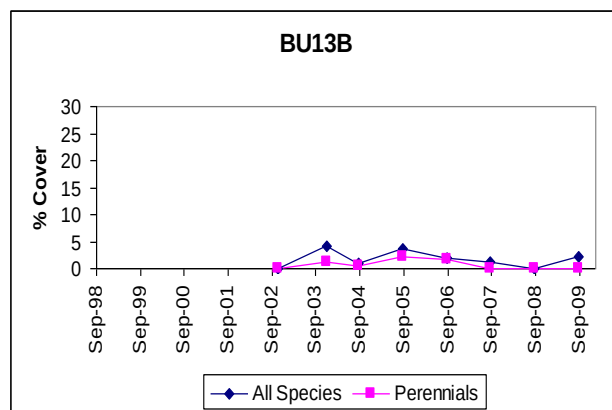
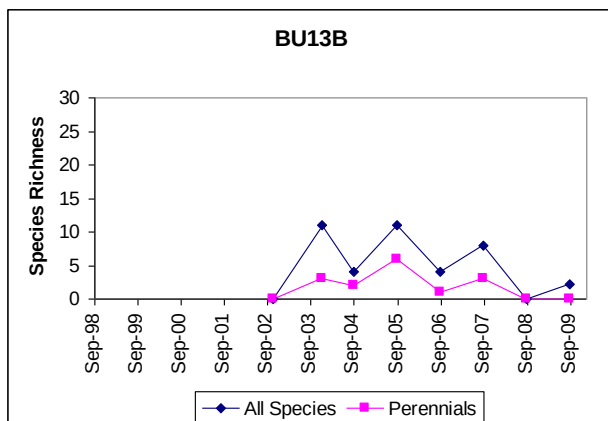
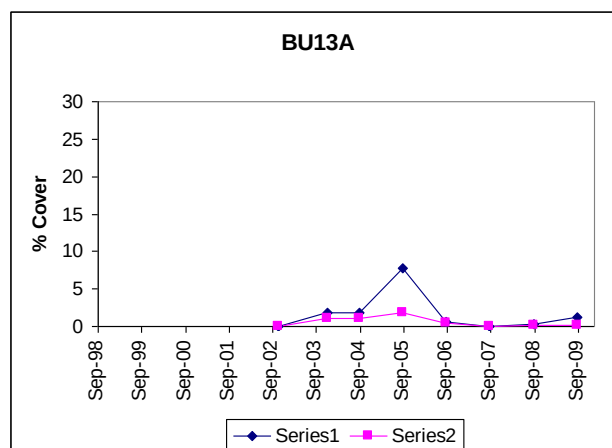
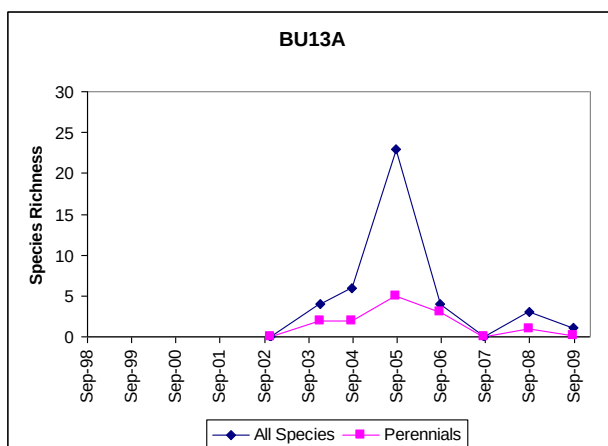
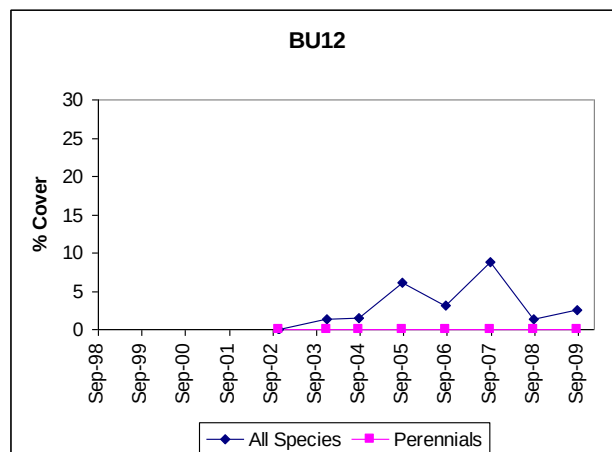
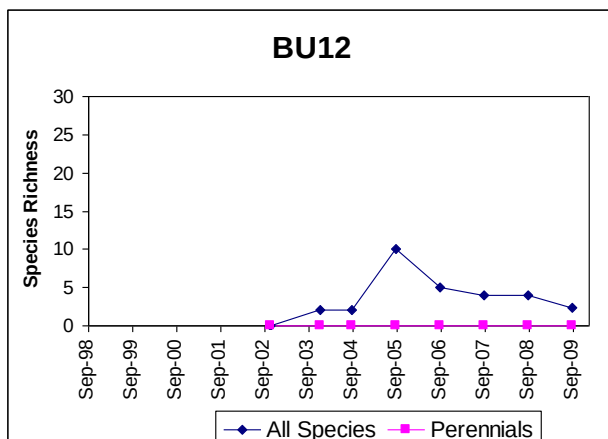
COVER (%)	Quadrat total		Quadrat total
Tree/tall shrub	0	Long-lived perennial	0
Shrub/subshrub	0	Biennial	0
Grass	0	Ephemeral/annual	0.5
Herb	0.5	All species	0.5
Shrubs & trees	0	All perennials	0
Grasses & herbs	0.5	Alien species	0.2

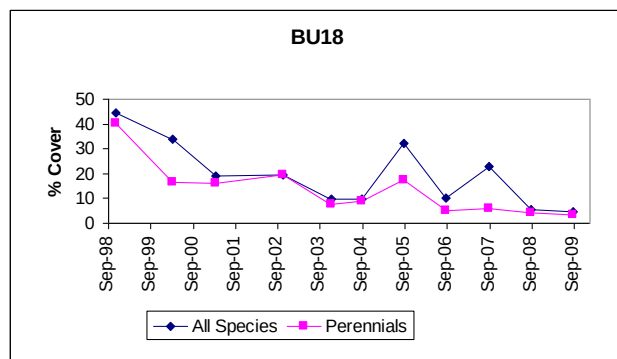
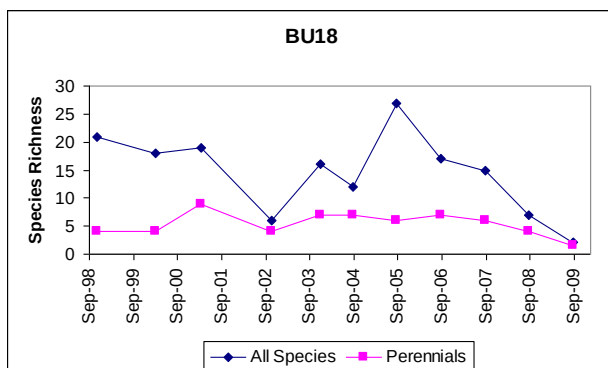
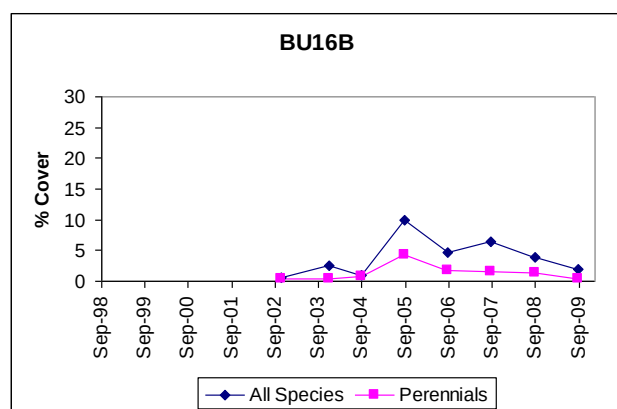
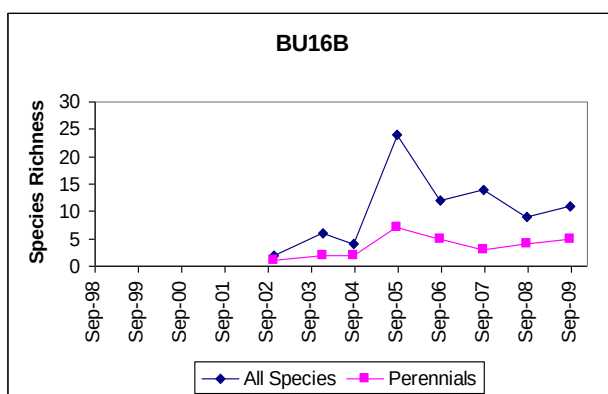
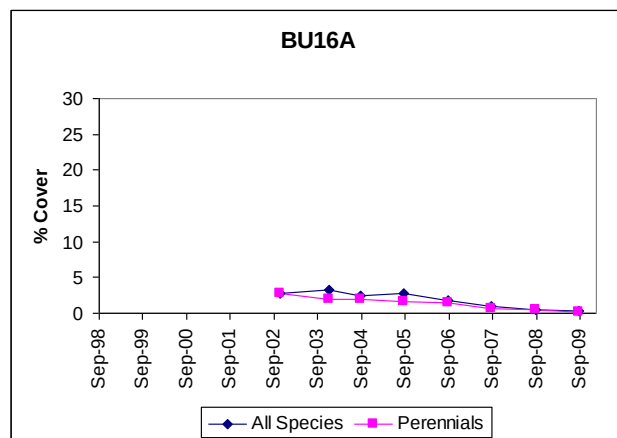
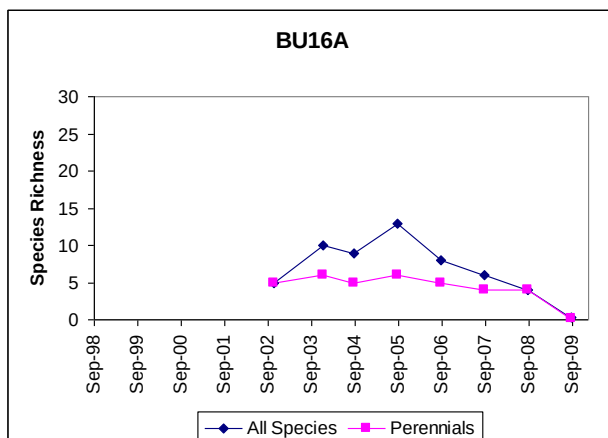
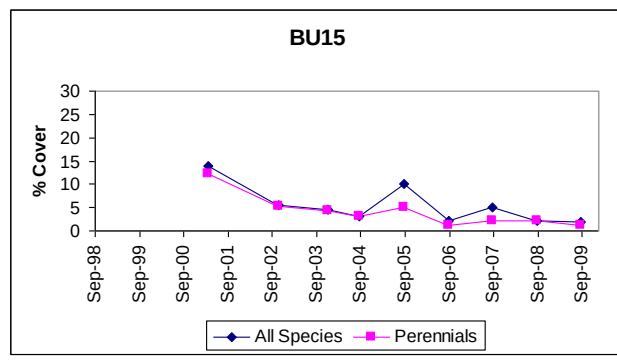
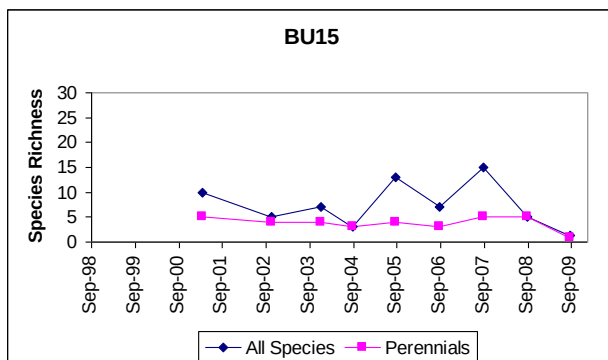
APPENDIX B: SUMMARY OF SPECIES RICHNESS AND COVER INFORMATION FOR INDIVIDUAL SITES

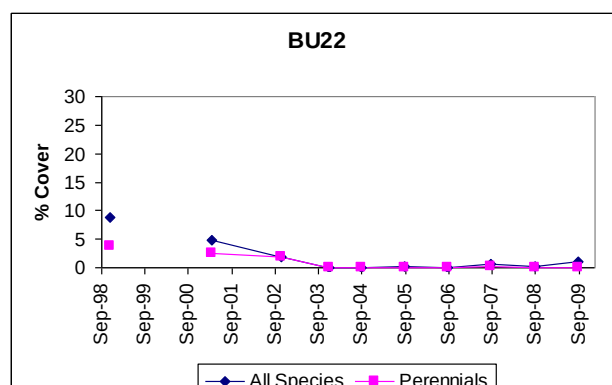
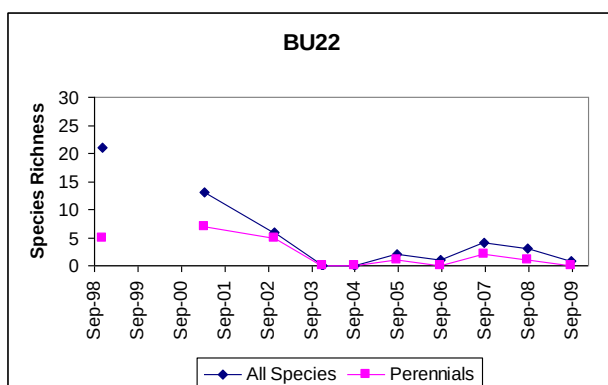
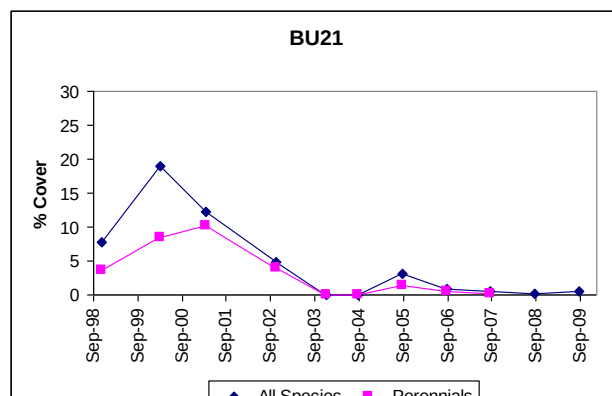
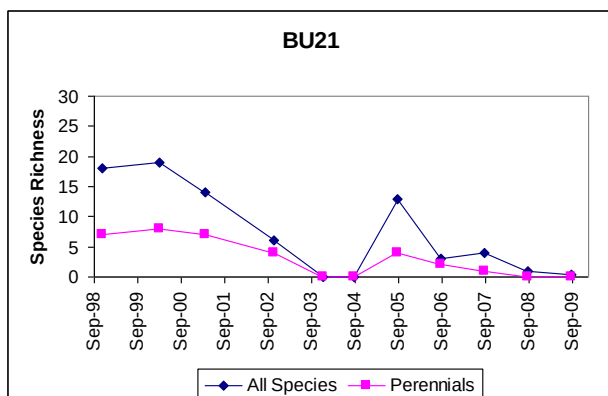
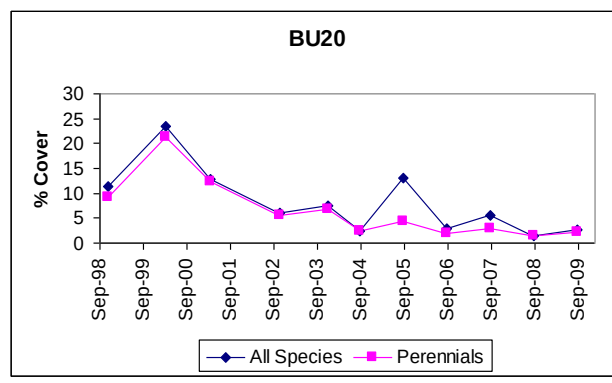
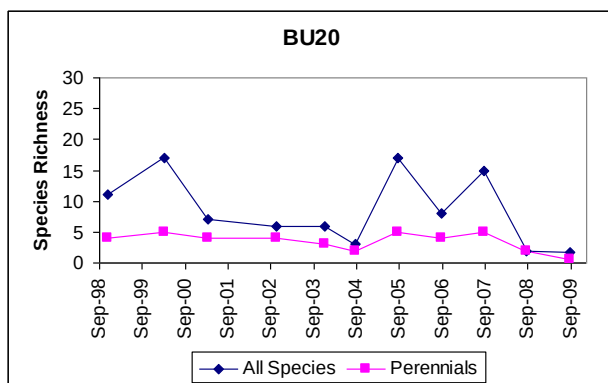
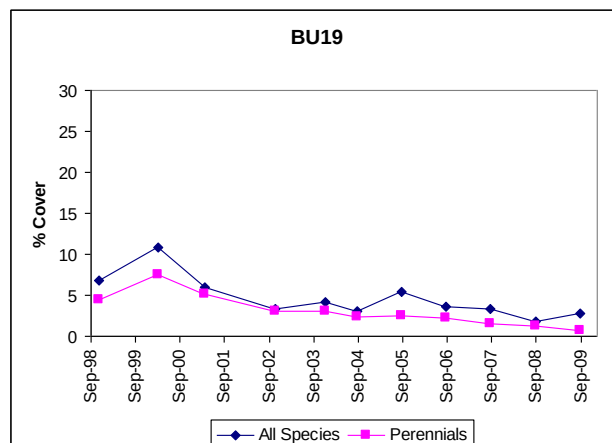
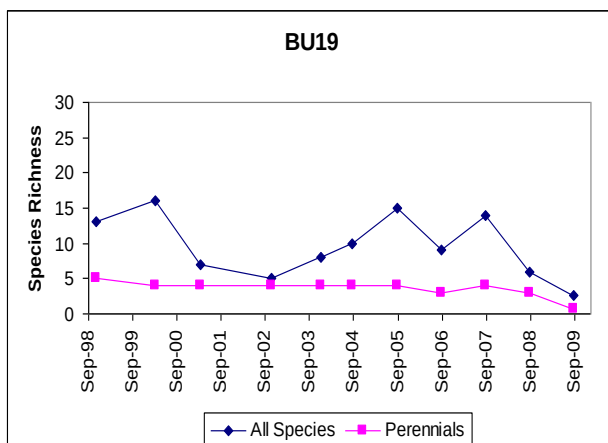


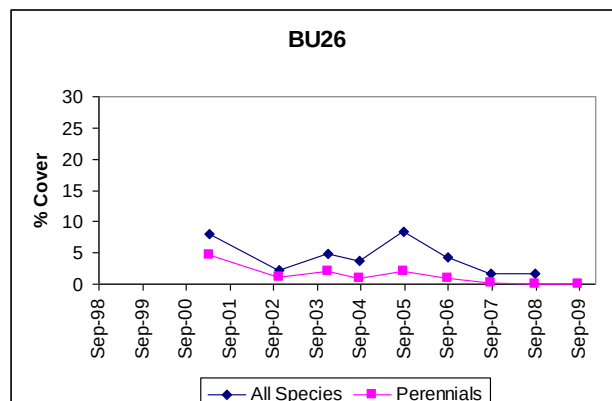
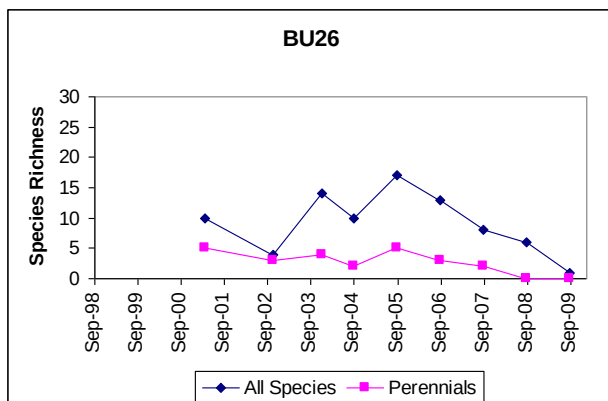
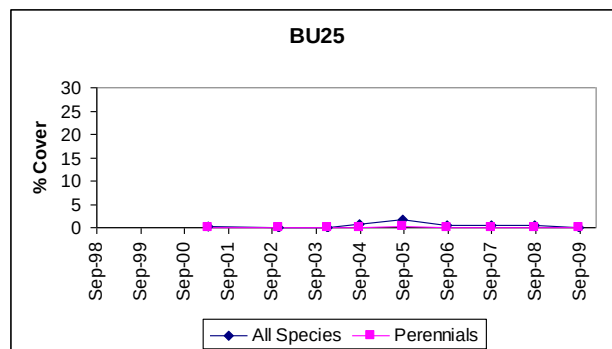
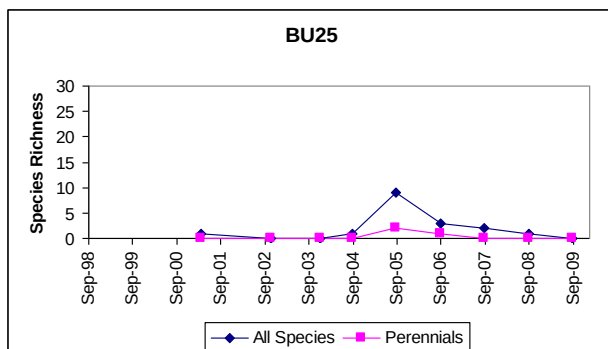
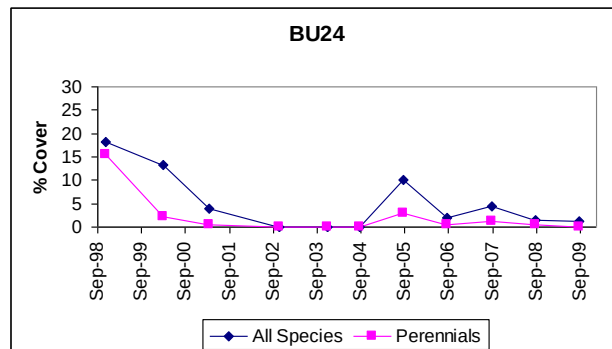
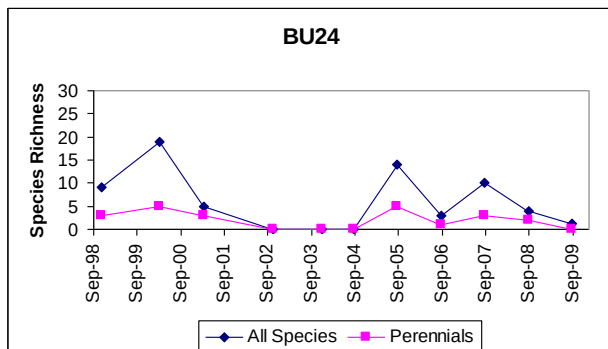
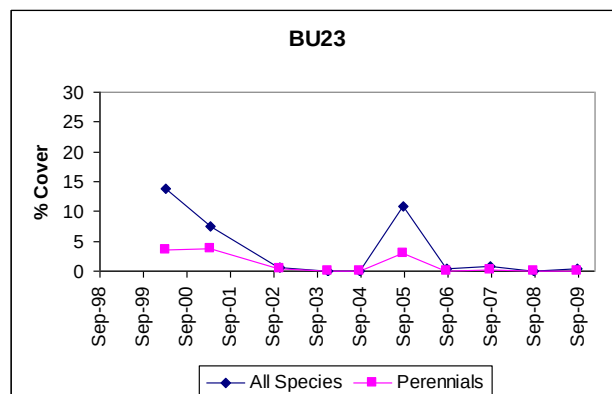
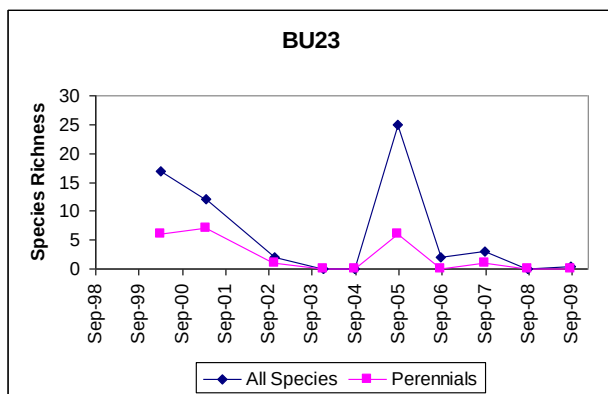


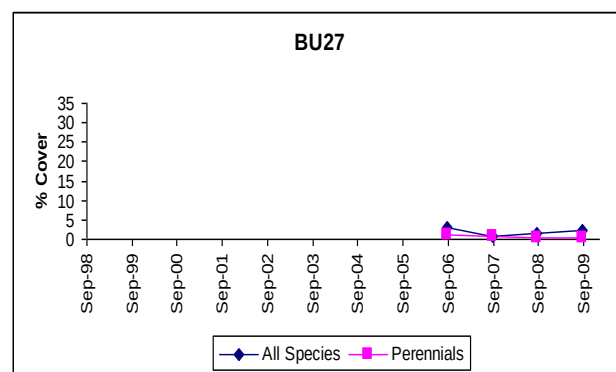
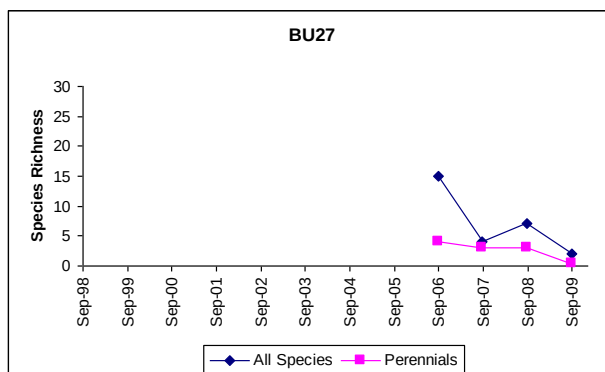












APPENDIX C: DATA FOR BIOLOGICAL SURVEY OF SOUTH AUSTRALIA SITE AT BU15

Quadrat Patch Description

BU15	TJF 270301	AMG 54J 362460 6658614 AGD84	GPS-derived, no SA,
Beverley Mine 2 km	High outwash plains; puffing clays with gibber	Landform PEP	Element 102
0 degrees slope, no aspect	Strew size 1	Strew cover 2	No fire scars
60% bare earth	Nil litter	Clay loam	

Vegetation quadrat data (2001 - 2007)

Species	Overstorey, Emergent,	Life form	Cover- abundance Mar 2001	Life stage Mar 2001	Cover- abundance Oct 2002	Cover- abundance Dec 2003	Life stage Dec 2003	Cover- abundance Sept 2004	Cover- abundance Sept 2005	Life stage Sept 2005	Cover- abundance Sept 2006	Cover- abundance Sept 2007	Life stage Sept 2007	Cover- abundance Sept 2008	Life stage Sept 2008	Cover- abundance Sept 2009	Life stage Sept 2008
<i>Astrebla pectinata</i>	O	GL	2	V	2	2	D	2	1	D	1	1	D	1	D	T	D
<i>Eragrostis eriopoda</i>	U	GL	T	D	1	T	D	T									
<i>Maireana aphylla</i>	O	SC						N	N	M	N	V	V	N	M	N	V
<i>Dissocarpus paradoxus</i>	U	SD			N	N	V		1	M	1	T	M	T	M	T	M
<i>Maireana ciliata</i>	U	SD	N	D													
<i>Malacocera albolanata</i>	U	SD	T	D	N	N	V	N	T	I	1			N	M	T	M
<i>Neobassia proceriflora</i>	U	SD				T	M		2	M	1	1	M	T	D	T	M
<i>Sclerolaena brachyptera</i>	U	SD	1	M	T	1	V	1	1	M	T	T	I	T	V	T	V
<i>Sclerolaena parallelispis</i>	U	SD							1	M							
<i>Sclerolaena</i>	U	SD				T	M	N			T			T	M		

Species	Overstorey, Emergent,	Life form	Cover- abundance Mar 2001	Life stage Mar 2001	Cover- abundance Oct 2002	Cover- abundance Dec 2003	Life stage Dec 2003	Cover- abundance Sept 2004	Cover- abundance Sept 2005	Life stage Sept 2005	Cover- abundance Sept 2006	Cover- abundance Sept 2007	Life stage Sept 2007	Cover- abundance Sept 2008	Life stage Sept 2008	Cover- abundance Sept 2009	Life stage Sept 2008
<i>longicuspis</i>																	
<i>Sclerolaena divaricata</i>	U	SD	1	M	1	1	M	1	T	M	1	1	M	1	M	T	M
<i>Sclerolaena ventricosa</i>	U	SD	1	M	1	1	V	1			T	T	M	T	M	T	M
<i>Arabidella filifolia</i>	U	SD										N	V				
<i>Arabidella nasturtium</i>	U	J							1	F	N	1	X				
<i>Atriplex holocarpa</i>	U	J				N	M	N	1	M	T	1	M	T	D	T	M
<i>Atriplex lindleyi</i>	U	SD	N	D		N	V		N	M						T	M
<i>Boerhavia dominii</i>	U	J	N	D													
<i>Brachyscome ciliaris</i> var. <i>lanuginosa</i>	U	J							T	V		N	V				
<i>Bulbine alata</i>	U	J						N									
<i>Convolvulus remotus</i>	U	J							T	F	1	T	M				
<i>Calotis hispidula</i>	U	J							1	M	1	1	F			T	M
<i>Daucus glochidiatus</i>	U	J										T	M	N	M		
<i>Enneapogon avenaceus</i>	U	GL	T	D		N	X										
<i>Erodium carolinianum</i>	U	J							T	V	N						
<i>Euphorbia stevenii</i>	U	J				N	V		T	M						N	V

Species	Overstorey, Emergent,	Life form	Cover- abundance Mar 2001	Life stage Mar 2001	Cover- abundance Oct 2002	Cover- abundance Dec 2003	Life stage Dec 2003	Cover- abundance Sept 2004	Cover- abundance Sept 2005	Life stage Sept 2005	Cover- abundance Sept 2006	Cover- abundance Sept 2007	Life stage Sept 2007	Cover- abundance Sept 2008	Life stage Sept 2008	Cover- abundance Sept 2009	Life stage Sept 2008
<i>Flaveria australasica</i>																T	V
<i>Ixiolaena chloroleuca</i>	U	J				N	V	N				N	F				
<i>Lepidium phlebopetalum</i>	U	J						N	N	M		T	FM			N	V
<i>Lotus cruentus</i>	U	J						N									
<i>Malacocera albolanata</i>	U	SD										N	M				
<i>Malvastrum americanum</i>	U	J	N	V		T	M										
<i>Minuria leptophylla</i>	U	J	N	D		N	M										
<i>Pimelea simplex</i>	U	J	T	D		T	M		T	F		T	F	T	X		
<i>Portulaca oleracea</i>	U	J				T	V										
<i>Rhodanthe floribunda</i>	U	J						N	T	M	T	T	F				
<i>Rhodanthe microglossa</i>	U	J						N	T	F		T	F				
<i>Rhodanthe pygmaea</i>	U	J									N						
<i>Rhodanthe stricta</i>	U	J	N	D							N	T	F				
<i>Salsola tragus</i>	U	J	T	D	T	T	D	N	T	M	T	T	V	T	D	T	D
<i>Sida fibulifera</i>	U	SD	T	V					T	V		N	V			N	V
<i>Sida trichopoda</i>	U	SD				T	I	N								T	V
<i>Solanum</i>	U	J				N	M										

Species	Overstorey, Emergent,	Life form	Cover- abundance Mar 2001	Life stage Mar 2001	Cover- abundance Oct 2002	Cover- abundance Dec 2003	Life stage Dec 2003	Cover- abundance Sept 2004	Cover- abundance Sept 2005	Life stage Sept 2005	Cover- abundance Sept 2006	Cover- abundance Sept 2007	Life stage Sept 2007	Cover- abundance Sept 2008	Life stage Sept 2008	Cover- abundance Sept 2009	Life stage Sept 2008
<i>coactiliferum</i>																	
<i>Stenopetalum lineare</i>	U	J							T	M		T	M				
<i>Swainsona oligophylla</i>	U	J							T	M							
<i>Trianthema triquetra</i>	U	J				N	X									N	X
<i>*Tribulus terrestris</i>																T	D
<i>Vittadinia eremaea</i>	U	J				N	M		T	V		T	FM			N	V
<i>Zygophyllum iodocarpum</i>	U	J							1	M	T	1	M				
<i>Zygophyllum prismatothecum</i>	U	J							T	M	N	T	M				

APPENDIX D: DATA FROM NEW ONE HECTARE QUADRAT AT BE32

Abundance scores are derived Heard and Channon (1997): N = not many (1-10 plants per hectare and <5% cover); T = sparsely present (cover <5%); 1 = plentiful (but cover <5%).

Life Stage: V = vegetative, X = recently shed fruit, D = dead or dormant, I = immature fruits, B = buds, M = mature fruits.

Species	Overstorey/Understorey	Cover Abundance Sept 2009	Life Stage Sept 2009
<i>Acacia ligulata</i>	O	N	V
<i>Acacia victoriae</i>	O	N	X
<i>Astrebla pectinata</i>	U	T	V
<i>Boerhavia dominii</i>	U	T	D
* <i>Brassica tournefortii</i>	U	T	D
<i>Einadia nutans</i>	U	N	V
<i>Enchylaena tomentosa</i>	U	T	I
<i>Eucalyptus camaldulensis</i>	O	1	B,M
<i>Melaleuca glomerata</i>	O	1	M
<i>Portulaca oleracea</i>	U	N	V
<i>Rhagodia spinescens</i>	U	T	I
* <i>Tribulus terrestris</i>	U	T	M

APPENDIX F: PLANT LIST FOR THE BEVERLEY URANIUM MINE SITE AND ADJACENT AREAS

Sources: Williams (1979), Fatchen Environmental (2001, 2002), annual report survey data, Badman (2006b, 2007b).

ACANTHACEAE

Rostellularia adscendens var. *pogonantha* Pink Tongues

AIZOACEAE

Glinus lotoides Hairy Carpet-weed
Gunniopsis quadrifida Sturt's Pigface
Tetragonia eremaea Desert Spinach
Trianthema triquetra Red Spinach

AMARANTHACEAE

Amaranthus grandiflorus Large-flower Amaranth
Ptilotus exaltatus Pink Mulla Mulla
Ptilotus obovatus Silver Mulla Mulla

ASCLEPIADACEAE

Cynanchum floribundum Desert Cynanchum
Marsdenia australis Native Pear
Sarcostemma viminalis ssp. *australe* Caustic Bush

BORAGINACEAE

Heliotropium asperum Rough Heliotrope
**Heliotropium curassavicum* Smooth Heliotrope
Trichodesma zeylanicum Camel Bush

CAMPANULACEAE

Isotoma petraea Rock Isotome
Wahlenbergia communis Tufted Bluebell

CAPPARACEAE

Capparis mitchellii Native Orange

CARYOPHYLLACEAE

Spergularia marina Salt Sand-spurrey

CASUARINACEAE

Casuarina pauper Black Oak

CHENOPODIACEAE

Atriplex angulata Fan Saltbush
Atriplex holocarpa Pop Saltbush
Atriplex lindleyi ssp. *inflata* Corky Saltbush
Atriplex nummularia Old-man Saltbush
Atriplex spongiosa Pop Saltbush
Atriplex velutinella Sandhill Saltbush

<i>Atriplex vesicaria</i>	Bladder Saltbush
<i>Chenopodium desertorum</i>	Desert Goosefoot
* <i>Chenopodium murale</i>	Nettle-leaf Goosefoot
<i>Chenopodium pumilio</i>	Clammy Goosefoot
<i>Dissocarpus biflorus</i>	Two-horn Saltbush
<i>Dissocarpus paradoxus</i>	Ball Bindyi
<i>Einadia nutans</i>	Climbing Saltbush
<i>Enchylaena tomentosa</i>	Ruby Saltbush
<i>Eriochiton sclerolaenoides</i>	Woolly-fruit Bluebush
<i>Maireana aphylla</i>	Cotton-bush
<i>Maireana astrotricha</i>	Low Bluebush
<i>Maireana brevifolia</i>	Short-leaf Bluebush
<i>Maireana ciliata</i>	Hairy Fissure-plant
<i>Maireana georgei</i>	Satiny Bluebush
<i>Maireana pyramidata</i>	Black Bluebush
<i>Maireana spongiocarpa</i>	Spongy-fruit Bluebush
<i>Malacocera tricornis</i>	Goat-head Soft-horns
<i>Neobassia proceriflora</i>	Desert Glasswort
<i>Osteocarpum acropterum</i> var. <i>acropterum</i>	Tuberculate Bonefruit
<i>Rhagodia spinescens</i>	Spiny Saltbush
<i>Salsola kali</i>	Buckbush
<i>Sclerolaena bicornis</i>	Goat-head Bindyi
<i>Sclerolaena brachyptera</i>	Short-wing Bindyi
<i>Sclerolaena decurrens</i>	Green Bindyi
<i>Sclerolaena diacantha</i>	Grey Bindyi
<i>Sclerolaena divaricata</i>	Tangled Bindyi
<i>Sclerolaena intricata</i>	Tangled Bindyi
<i>Sclerolaena lanicuspis</i>	Spinach Bindyi
<i>Sclerolaena limbata</i>	Pearl Bindyi
<i>Sclerolaena longicuspis</i>	Long-spine Bindyi
<i>Sclerolaena obliquicuspis</i>	Oblique-spined Bindyi
<i>Sclerolaena patenticuspis</i>	Spear-fruit Bindyi
<i>Sclerolaena ventricosa</i>	Salt Bindyi

COMPOSITAE

<i>Brachyscome ciliaris</i> var. <i>lanuginosa</i>	Woolly Variable Daisy
<i>Brachyscome lineariloba</i>	Hard-head Daisy
<i>Calotis cymbacantha</i>	Showy Burr-daisy
<i>Calotis hispidula</i>	Hairy Burr-daisy
* <i>Centaurea melitensis</i>	Malta Thistle
<i>Chrysocephalum apiculatum</i>	Common Everlasting
<i>Flaveria australasica</i>	Yellow Twin-stem
<i>Glossocardia bidens</i>	Native Cobbler's-pegs
<i>Gnephosis arachnoidea</i>	Spidery Button-flower
<i>Isoetopsis graminifolia</i>	Grass Cushion
* <i>Lactuca serriola</i>	Prickly Lettuce
<i>Leiocarpa leptolepis</i>	Pale Plover-daisy
<i>Leiocarpa websteri</i>	Narrow Plover-daisy
<i>Minuria cunninghamii</i>	Bush Minuria
<i>Minuria denticulata</i>	Woolly Minuria

<i>Minuria leptophylla</i>	Minnie Daisy
<i>Pluchea rubelliflora</i>	
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed
<i>Pterocaulon sphacelatum</i>	Apple-bush
<i>Rhodanthe floribunda</i>	White Everlasting
<i>Rhodanthe microglossa</i>	Clustered Everlasting
<i>Rhodanthe moschata</i>	Musk Daisy
<i>Rhodanthe pygmaea</i>	Pigmy Daisy
<i>Rhodanthe stricta</i>	Slender Everlasting
<i>Rhodanthe uniflora</i>	Woolly Daisy
<i>Senecio gregorii</i>	Fleshy Groundsel
<i>Senecio lanibracteatus</i>	Inland Shrubby Groundsel
<i>Senecio magnificus</i>	Showy Groundsel
<i>Senecio odoratus</i>	Scented Groundsel
<i>Senecio quadridentatus</i>	Cotton Groundsel
* <i>Sonchus oleraceus</i>	Common Sow-thistle
<i>Streptoglossa adscendens</i>	Desert Daisy
<i>Vittadinia eremaea</i>	Desert New Holland Daisy

CONVOLVULACEAE

<i>Convolvulus erubescens</i> complex	
<i>Convolvulus remotus</i>	Grassy Bindweed

CRUCIFERAE

<i>Arabidella nasturtium</i>	Yellow Cress
<i>Arabidella trisecta</i>	Shrubby Cress
<i>Lepidium oxytrichum</i>	Green Peppergrass
<i>Lepidium phlebopetalum</i>	Veined Peppergrass
<i>Menkea australis</i>	Fairy Spectacles
* <i>Sisymbrium erysimoides</i>	Smooth Mustard

CUCURBITACEAE

* <i>Citrullus colocynthis</i>	Colocynth
* <i>Cucumis myriocarpus</i>	Paddy Melon
<i>Mukia maderaspatana</i>	Snake Vine

CYPERACEAE

<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge
<i>Cyperus</i> sp.	Flat-sedge
<i>Schoenoplectus litoralis</i>	Shore Club-rush

EUPHORBIACEAE

<i>Chamaesyce australis</i>	
<i>Chamaesyce drummondii</i>	
<i>Euphorbia stevenii</i>	Bottletree Spurge
<i>Euphorbia tannensis</i> ssp. <i>eremophila</i>	Desert Spurge
* <i>Ricinus communis</i>	Castor Oil Plant

FRANKENIACEAE

<i>Frankenia serpyllifolia</i>	Thyme Sea-heath

GENTIANACEAE

**Centaurium erythraea*

Common Centaury

GERANIACEAE

Erodium carolinianum

Clammy Heron's-bill

Erodium cygnorum

Blue Heron's-bill

GOODENIACEAE

Goodenia calcarata

Streaked Goodenia

Goodenia lunata

Stiff Goodenia

Goodenia sp.

Goodenia

Scaevola spinescens

Spiny Fanflower

GRAMINEAE

Aristida contorta

Curly Wire-grass

Aristida latifolia

Feather-top Wire-grass

Aristida nitidula

Brush Three-awn

Astrebla lappacea

Curly Mitchell-grass

Astrebla pectinata

Barley Mitchell-grass

Austrostipa sp.

Spear-grass

**Cenchrus ciliaris*

Buffel Grass

Chloris pectinata

Comb Windmill Grass

Cymbopogon ambiguus

Lemon-grass

**Cynodon dactylon* var. *dactylon*

Couch

Dactyloctenium radulans

Button-grass

Dichanthium sericeum

Silky Blue-grass

Digitaria ammobila

Spider Grass

Digitaria brownii

Cotton Panic-grass

Enneapogon avenaceus

Common Bottle-washers

Enneapogon caeruleus var. *caeruleus*

Blue Bottle-washers

Enneapogon polyphyllus

Leafy Bottle-washers

Eragrostis australasica

Cane-grass

Eragrostis dielsii var. *dielsii*

Mulka

Eragrostis eriopoda

Woollybutt

Eragrostis setifolia

Bristly Love-grass

Eragrostis xerophila

Knotty-butt Neverfail

Eulalia aurea

Silky Brown-top

Leptochloa digitata

Umbrella Cane-grass

Panicum decompositum var. *decompositum*

Native Millet

**Polypogon monspeliensis*

Annual Beard-grass

**Schismus barbatus*

Arabian Grass

Setaria constricta

Knotty-butt Paspalidium

Sporobolus actinocladius

Ray Grass

Themeda triandra

Kangaroo Grass

Tragus australianus

Small Burr-grass

Triodia irritans

Spinifex

Tripogon loliiformis

Five-minute Grass

Triraphis mollis

Purple Plume Grass

HALORAGACEAE

Haloragis aspera

Rough Raspwort

LABIATAE

**Mentha spicata*

Spearmint

Teucrium racemosum

Grey Germander

LEGUMINOSAE

Acacia aneura

Umbrella Bush

Acacia ligulata

Umbrella Wattle

Acacia oswaldii

Dead Finish

Acacia tetragonophylla

Elegant Wattle

Acacia victoriae

Downy Loose-flowered Rattle-pod

Crotalaria eremaea ssp. *eremaea*

Cullen australasicum

Tall Scurf-pea

Cullen patens

Spreading Scurf-pea

Goodia medicaginea

Western Golden-tip

Isotropis wheeleri

Wheeler's Lamb-poison

Lotus cruentus

Red-flower Lotus

Senna artemisioides ssp. *coriacea*

Broad-leaf Desert Senna

Senna artemisioides ssp. *helmsii*

Blunt-leaf Senna

Senna artemisioides ssp. *oligophylla*

Limestone Senna

Senna artemisioides ssp. *petiolaris*

Twin-leaf Desert Senna

Senna artemisioides ssp. *zygophylla*

Sturt Desert Pea

Swainsona formosa

Swainsona oligophylla

Swainsona sp.

Swainson-pea

Swainsona swainsonioides

Downy Swainson-pea

Templetonia egena

Broombush Templetonia

Trigonella suavissima

Sweet Fenugreek

LILIACEAE

Bulbine alata

Winged Bulbine-lily

LORANTHACEAE

Amyema preissii

Wire-leaf Mistletoe

Lysiana exocarpi ssp. *exocarpi*

Harlequin Mistletoe

MALVACEAE

Abutilon halophilum

Plains Lantern-bush

Abutilon leucopetalum

Desert Lantern-bush

Gossypium sturtianum var. *sturtianum*

Sturt's Desert Rose

Hibiscus krichauffianus

Velvet-leaf Hibiscus

Malva behriana

Australian Hollyhock

**Malva parviflora*

Small-flower Marshmallow

**Malva* sp.

Mallow

Malvastrum americanum var. *americanum*

Malvastrum

Sida ammophila

Sand Sida

Sida corrugata

Corrugated Sida

Sida fibulifera

Pin Sida

<i>Sida intricata</i>	Twiggy Sida
<i>Sida phaeotricha</i>	Hill Sida
<i>Sida trichopoda</i>	High Sida
MYOPORACEAE	
<i>Eremophila duttonii</i>	Harlequin Emubush
<i>Eremophila freelingii</i>	Rock Emubush
<i>Eremophila latrobei</i>	Crimson Emubush
<i>Eremophila longifolia</i>	Weeping Emubush
<i>Eremophila sturtii</i>	Turpentine Bush
<i>Myoporum montanum</i>	Native Myrtle
MYRTACEAE	
<i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>	Northern River Red Gum
<i>Eucalyptus gillii</i>	Curly Mallee
<i>Eucalyptus intertexta</i>	Gum-barked Coolibah
<i>Melaleuca dissitiflora</i>	
<i>Melaleuca glomerata</i>	Inland Paper-bark
NYCTAGINACEAE	
<i>Boerhavia dominii</i>	Tar-vine
<i>Commicarpus australis</i>	Pink Gum-fruit
PITTOSPORACEAE	
<i>Pittosporum angustifolium</i>	Native Apricot
PLANTAGINACEAE	
<i>Plantago drummondii</i>	Dark Plantain
POLYGONACEAE	
* <i>Acetosa vesicaria</i>	Rosy Dock
<i>Muehlenbeckia florulenta</i>	Lignum
PORTULACACEAE	
<i>Portulaca oleracea</i>	Common Purslane
PRIMULACEAE	
* <i>Anagallis arvensis</i>	Pimpernel
PROTEACEAE	
<i>Hakea ednieana</i>	Flinders Ranges Corkwood
<i>Hakea leucoptera</i> ssp. <i>leucoptera</i>	Silver Needlewood
SANTALACEAE	
<i>Santalum lanceolatum</i>	Plumbush
SAPINDACEAE	
<i>Alectryon oleifolius</i> ssp. <i>canescens</i>	Bullock Bush
<i>Dodonaea viscosa</i> ssp. <i>angustissima</i>	Narrow-leaf Hop-bush

SOLANACEAE

**Nicotiana glauca*
Nicotiana velutina
Solanum chenopodium
Solanum coactiliferum
Solanum ellipticum
**Solanum nigrum*
Solanum quadriloculatum

Tree Tobacco
Velvet Tobacco
Goosefoot Potato-bush
Tomato-bush
Velvet Potato-bush
Black Nightshade
Plains Nightshade

THYMELAEACEAE

Pimelea microcephala
Pimelea simplex ssp. *continua*
Pimelea trichostachya

Shrubby Riceflower
Desert Riceflower
Spiked Riceflower

TYPHACEAE

Typha domingensis

Narrow-leaf Bulrush

UMBELLIFERAE

Daucus glochidiatus
Trachymene glaucifolia

Native Carrot
Blue Parsnip

ZYGOPHYLLACEAE

**Tribulus terrestris*
Zygophyllum ammophilum
Zygophyllum apiculatum
Zygophyllum prismatothecum
Zygophyllum sp.

Caltrop
Sand Twinleaf
Pointed Twinleaf
Square-fruit Twinleaf
Twinleaf

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APPENDIX C: Annual Ecosystem Function Analysis Monitoring Report

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Heathgate Resources Pty Ltd Beverley Uranium Mine

Ecosystem Function Analysis of Rehabilitated Areas

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Ecosystem Function Analysis of Rehabilitated Landforms

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Executive Summary

Ecosystem Function Analysis (EFA) was conducted on 26 permanent monitoring sites at the Beverley Uranium Mine (Beverley). EFA provides data relating to landscape functioning, vegetation establishment and habitat development. The data has been compared to local analogue sites, which were re-assessed to reflect any changes resulting from natural climatic fluctuations. In successful rehabilitation, steady improvements should be expected, in soil structure and soil protection, vegetative cover and development, and stability of erosion features. Therefore, EFA data should gradually trend upward and plateau as the ecosystem becomes stable and self-sustaining. Results over time will indicate if the ecosystems have achieved these self-sustaining levels and can withstand climatic fluctuations.

The majority of rehabilitated areas at Beverley were drill pads less than 200 m² in size. A number of treatments were applied to rehabilitated areas ranging from contour ripping of the topsoil to blending of the landforms to match that of the surrounding landscape. None of the rehabilitation however, had been seeded, with the revegetation strategy to allow for encroachment from adjacent 'natural' communities. Three other landforms had been rehabilitated, namely the Airlift Pit, Clay Batching Pad and a Calcrete Borrow Pit. The borrow pit differed slightly in its slope and surface composition, and surface ripping against the contour might lead to the shedding of resources during high rainfall events.

In December 2008, 70 mm of rain was recorded at Beverley, most of it occurring within a week. This triggered the largest ephemeral response of vegetation since EFA monitoring began in 2006. Numerous annual and opportunistic species recruited from seed and plants that had been in states of dormancy actively re-sprouted. The ten-months following this rainfall event were some of the driest on record, with no month between February and October 2009, exceeding the longer term average. At the time of assessment, much of the plant matter had desiccated or dissipated. A large amount of biomass in the form of root structures and seed resources remained below the surface and was integrated with the topsoil, aiding overall stability.

The landscape function indices for resource-accumulating 'patch' zones improved as a result of increased litter and soil protection, but the proportion of each transect taken up by these zones was so small, that this translated to only a negligible difference in the indices for infiltration and nutrient cycling. Development of physical and organic (cryptogam) crusts had continued, and while remaining fragile and easily broken, these crusts often contributed to the slightly higher stability indexes observed, though most remained below those of the better-developed analogue transects.

There was a slight increase in the formation of crabholes and crack features following the previous December's rainfall, with the highly-dispersive clay subsoil eroding around existing crack edges. These depressions, however, are a vital sink for seed, litter and sediment resources, particularly in the absence of perennial vegetation. The capacity for the ripped rehabilitation to retain resources had also declined as the bank and trough structures continued to flatten.

The surrounding plains were dominated by ephemeral and short-lived species, such as *Sclerolaena* (copperburr) species, which are dependent on and fluctuate with seasonal conditions. As a result of the opportunistic establishment after the previous summer's rainfall, the plant cover and density values were generally the highest of the four years monitoring, and for rehabilitated transects, sometimes exceeded those of their most comparable analogues. The ephemeral flush included an increase in the presence of coloniser species, particularly on the rehabilitation. Whilst many of the individuals had since senesced or been removed, the contribution to the seedbank was evident, where the wind had blown resources against remaining obstacles. This is one of the first stages in their ecological succession.

The most common longer-lived species on the upland and lowland plains was *Astrebla pectinata* (barley Mitchell grass). It had both re-sprouted from dormant tussocks and recruited from seed following the summer rainfall. Creeklines, banks and adjacent areas were dominated by more woody and longer-lived perennial species, although none of the rehabilitation was truly representative of these areas. At one transect the measurement of the *Acacia tetragonophylla* (dead finish) overstorey was possible, due to the presence of individuals exceeding three metres in height.

In the weeks following the 2009 assessment, Beverley received a high rainfall event, with over 50 mm falling in a 48 hour period (half its annual average). This would have triggered an ephemeral flush comparable to that observed following the December 2008 rains. While this favours opportunistic and short-lived species, establishment of perennial species on the rehabilitation is dependent on consistent and more-reliable, follow-up rainfall. Given the appropriate conditions for their development, ongoing monitoring will identify whether the encroachment of these species onto the rehabilitated landforms and drill pads occurs as anticipated. This could lead to the achievement of stable and self-sustaining rehabilitated ecosystem.

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APPENDIX B EFA Transect Location Maps

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APPENDIX D Plant Species List, 2009

APPENDIX E Habitat Complexity, 2009

APPENDIX F Transect Photographs (Oct '08, Jan '09, Oct '09)

1. INTRODUCTION

The Beverley Uranium Mine is located 530 km north of Adelaide, 100 km east of Leigh Creek and 35 km north-west of Lake Frome in northern South Australia. The current mining lease occupies an area of approximately 117 km² on the Wooltana Pastoral Lease, and is subject to ongoing exploration and development. The surrounding area has a long history of pastoral disturbance as a result of previously high stocking rates.

The Beverley Uranium Mine is part of the Stony Plains Bioregion, and occurs mostly within the Mumpie land system, which is characterised by undulating gibber tablelands with gilgais and cracking clay soils. The landscape includes numerous temporal watercourses and drainage lines. The dominant vegetation type is open *Astrebla pectinata* (barley Mitchell grass) grassland with interspersing cover of annual or short-lived forbs such as *Sclerolaena* and *Dissocarpus* species. Occasional stands of *Maireana aphylla* (cottonbush) occur in lower lying areas, along with a sparse *Eremophila duttonii* (harlequin fuchsia bush) and *Acacia tetragonophylla* (dead finish) overstorey. The natural values of the mining lease are not considered unique to the operations and occur broadly in surrounding pastoral areas, and are protected within the nearby Gammon Ranges National Park.

The Beverley uranium deposit was discovered in 1969, with Heathgate Resources Pty Ltd, an affiliate of General Atomics, acquiring the lease in 1990. Feasibility studies and field leach trials occurred in 1997 and 1998, and commercial production commenced in 2001. Mineral exploration in the area is ongoing and has identified a number of viable deposits, which are likely to lead to future production.

Ore extraction is by the low impact In Situ Recovery (ISR) method, whereby the uranium is brought up in an acidic solution through a series of injection and recovery bores. As a result, there are no large waste landforms or stockpiles characteristic of open cut operations. Rehabilitation activities centre around the sealing of wells and the progressive revegetation of drill pad sites to a level comparable to the surrounding landscape.

Monitoring of rehabilitated areas allows ecosystem development to be quantified, and the information can be used to further improve future rehabilitation strategies. Ecosystem Function Analysis (EFA) is a monitoring system that provides time series data from assessments of landscape functioning, vegetative growth and habitat development. EFA data may be used to predict achievable and acceptable completion criteria for rehabilitation areas. Therefore, EFA is valuable as a tool for demonstrating progressive improvements in rehabilitation performance, eventually leading to financial bond recovery.

This report documents the fourth year of monitoring using EFA at the Beverley Uranium Mine. The objective of this report was to describe the current status of rehabilitation for all areas assessed, both in relation to expected performance at that site, and to analogue sites in the region. In 2009, Outback Ecology was also commissioned to assess the usefulness of the current data set to determine

appropriate and achievable targets for completion of successful rehabilitation, as part of the development of the mine site's completion criteria.

2. MATERIALS AND METHODS

2.1 Monitoring Methods

Each site was assessed using the principles of EFA. The approach for assessing landscape functioning, vegetative growth and habitat development using EFA is described by Tongway *et al.* (1997) and summarised in **Appendix A**. Using this approach, field data (soil condition, vegetation data, habitat complexity, crown separation ratio of weeds and erosion) was collected to provide information on key ecosystem processes, thereby reflecting the functionality of the ecosystem overall.

The main perennial plant species at Beverley are almost as dependent on seasonal conditions as the annual or ephemeral species, both contributing little to no cover values following extended dry periods. The criteria about what constitutes an eligible plant in terms of the vegetation assessment has been adjusted for all years of monitoring to better suit the surrounding plant communities. The main changes were inclusion of the short-lived species (such as *Sclerolaena* spp. and *Tribulus* spp.) which dominate the surrounding self-mulching clays, and the recording of individuals below the 5 cm basal width and 10 cm height prescribed in the formal methods (**Appendix A**). These changes were necessary in order to achieve values for cover and density at transects where perennial cover was (naturally) sparse or absent. There are, however, a number of data interpretation hazards that occur as a result, such as the influence of seasonal conditions on the variability of ephemeral cover, which can lead to an overestimation of long-term productive value during wetter than average seasons.

2.2 Climate

The climate is arid and extremely variable, occurring in the rain shadow of the Flinders Ranges. The average annual rainfall total received at Beverley since 2000 has been 106 mm, though this had only been exceeded once since 2003. Total rainfall for the 12 months preceding the assessment (November 2008 to October 2009) was 104 mm, 68% of which occurred in a single rain event in December 2008 (**Figure 1**). This resulted in a large flush of ephemeral vegetation, the remains of which still remained at the time of the 2009 assessment. Between February 2009 and October 2009 the monthly average had not been exceeded, with only 21 mm being recorded in the ten months preceding the assessment, the driest 10 months since operations began. Several weeks following the 2009 EFA monitoring 56 mm of rain fell in a 36 hour period, resulting in an immediate response by perennial grasses and forbs (David Hunt, pers. comm.). Within the region maximum mean temperatures reach 45.5°C in summer (December), with minimum mean temperatures of 6°C experienced in winter (July) (Beverley AER, 2005).

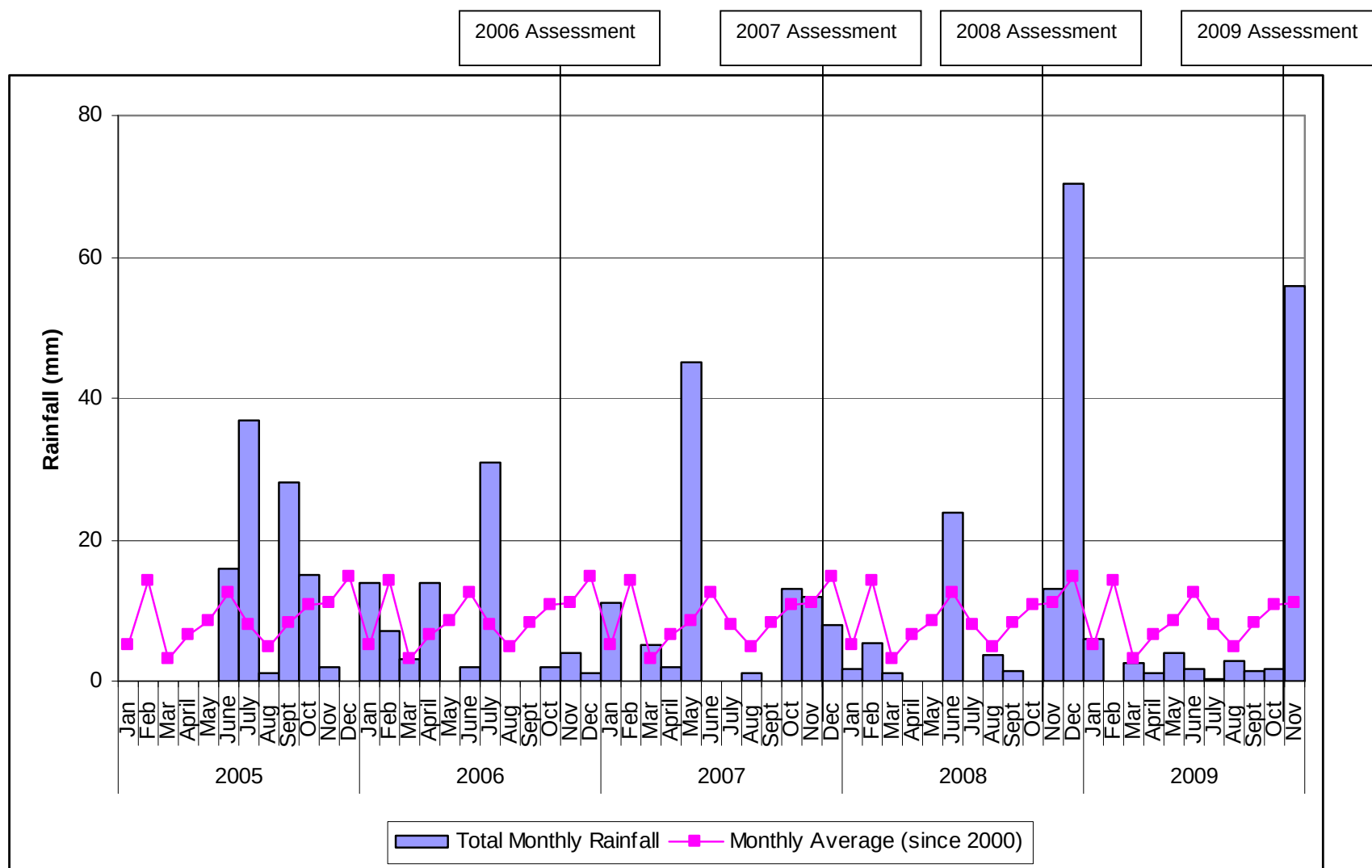


Figure 1: Monthly rainfall totals at Beverley between January 2005 and November 2009, showing timing of EFA assessments

2.3 Transect List and Areas Monitored

A total of 26 permanent EFA transects were monitored, comprising 12 analogue sites and 14 rehabilitated sites (**Table 1** and **Appendix B**). Two of the analogue transects were installed during the 2008 assessment to begin sampling undisturbed areas in the Beverley East and Four Mile West expansion areas. Of the rehabilitated sites, EFA17 was destroyed between 2007 and 2008 assessments and due to ongoing activity in the surrounds, was not reinstated or replaced.

Analogue sites provide representative values that are typical of the landscape surrounding the mine. Analogues are selected with attributes such as slope angle, topsoil cover and vegetation communities most similar to anticipated final attributes of the rehabilitation areas being assessed. Analogue sites were monitored to capture trends in EFA data resulting from seasonal and environmental fluctuations that may have occurred over the 12 month period between monitoring events. Field data and results from the rehabilitated landforms and drill pads were compared with field data from these analogue sites.

Three transects have been established on rehabilitated landforms (the Airlift Pit, Clay Batching Pad and Calcrete Borrow Pit), with the remainder located on rehabilitated drill pads representative of the differing land types and ages of rehabilitation occurring over the site. Due to the small footprint of drilling activities the majority of rehabilitated transects are between 10 and 15 metres in length. To prevent disturbance by other mine-related activities, transects in susceptible areas are fenced using steel droppers and a single-strand of plastic-coated wire. Since the 2008 assessment, the two newly installed transects had also been fenced and signs have been installed at all transects to identify the enclosed areas as monitoring sites.

Table 1: Transects within each analogue or rehabilitation area, including the age of rehabilitation and number of years monitored.

Areas monitored	Location	Year of Rehab.	Transect ID	Length	GPS position (WGS84)	N ^o Years monitored
Analogues	Mitchell Grass Uplands	N/A	EFA02	50m	54 J 363769 6658501	4
			EFA03	50m	54 J 362503 6658869	4
	Mitchell Grass Lowlands		EFA06	50m	54 J 364682 6658745	4
			EFA11	50m	54 J 364397 6657236	4
			EFA19	100m	54 J 365418 6657571	4
	Minor Creeks and Drainage Lines		EFA04	50m	54 J 363911 6659422	4
			EFA07	50m	54 J 365052 6659287	4
			EFA09	50m	54 J 365439 6660203	4
			EFA15	50m	54 J 365950 6660025	4
	Four Mile Floodplain		EFA12	50m	54 J 366010 6660687	4
	Beverley East (Zone 3)		EFA26	50m	54 J 368017 6658396	2
	Arkaroola Foothills (Four Mile West)		EFA27	50m	54 J 354381 6663560	2
Rehabilitated Landforms	Airlift Pit	2003	EFA01	50m	54 J 364673 6658299	4
	Clay Batch Pad	2005	EFA05	40m	54 J 364803 6659166	4
	Calcrete Borrow Pit	2007	EFA25	20m	54 J 351517 6639337	3
Rehabilitated Drill Pads	Mitchell Grass Uplands, Plains and Slopes	2006	EFA08	20m	54 J 364983 6659383	4
			EFA10	25m	54 J 364674 6658483	4
			EFA23	15m	54 J 365218 6657909	4
		2004	EFA20	15m	54 J 365337 6657594	4
			EFA21	15m	54 J 365372 6658000	4
			EFA22	15m	54 J 365372 6658000	4
		2001	EFA24	10m	54 J 364614 6660078	4
	Northern Creeklet	2005	EFA16	10m	54 J 365901 6660066	4
			EFA18	10m	54 J 366021 6660080	4
	Four Mile Creek Floodplain	2006	EFA14	15m	54 J 365924 6660660	4
		2004	EFA13	15m	54 J 365974 6660653	4

2.4 Presentation of results

Landscape Function Analysis and vegetation results have been grouped according to the age of rehabilitation. For the purpose of the EFA program, land units were grouped into the following broad categories: Mitchell Grass Upland Plains; Mitchell Grass Lowland Plains; Minor Creeks and Drainage Lines; Four Mile Creek Floodplain. For comparison with the disturbed sites, the LFA and vegetation indices of the Mitchell Grass Lowland and Upland Plains have been combined to provide average values for these land systems. Individual transect results are presented in **Appendix C**.

Most of the plants recorded in rehabilitated areas were on the edges of each area, reflecting that extant community encroachment is the proposed method of revegetation for the Beverley rehabilitation (as opposed to direct seedling). Difficulties in distinguishing the boundaries of the rehabilitated area could lead to varying interpretation of whether individuals should have been included in the vegetation assessment, or whether they actually occurred in pre-existing populations on adjacent 'natural' herblands. Scientific names for plants have been preferentially used, but common names have also been provided for the first mention of a species in each landform's discussion. A list of perennial species identified in the 2009 plant assessments is provided in **Appendix D**.

Habitat complexity results are displayed in a table which can be found in **Appendix E**. Plates for each transect, with photographs taken at opposite ends have been included following the discussion for each landform group.

Each site was photographed by David Hunt in January 2009 to exemplify the ephemeral response following the December rainfall event. These are presented with photographs from October 2008 and October 2009 assessments in **Appendix F**.

2.5 Notes on individual species

A number of species were common across the Beverley transects and are worthy of individual discussion:

***Sclerolaena* spp. (copperburr/povertybush):** This was the best represented genus at Beverley transects, with at least ten species being identified, occupying a suite of ecological niches and soil types. Among the most common were *S. divaricata* (golden poverty bush), *S. brachyptera* (short-winged copperburr), *S. longicuspis* (long-spined poverty bush) and *S. tricuspid* (streaked poverty bush). Generally short-lived, these species set copious amounts of seed (prickles) following rain, and remain dormant until the next available growing season (Cunningham et al., 1992). Adult plants either senesce or drop their leaves and enter a dormant phase at the on-set of dry conditions (*ibid*), but even then act as a trap for wind-blown soil and seed. The cover value provided by *Sclerolaena* species on Beverley transects is prone to increase and decrease with seasonal conditions.

***Astrebla pectinata* (barley Mitchell grass):** This was the most common perennial grass occurring in the Beverly area. It evades dry periods by losing its foliage and entering periods of dormancy as seemingly 'dead' bundles of sticks (Cunningham et al., 1992). The rains received in December 2008 promoted the recovery of

many *A. pectinata* individuals (**Plate 1**), as well as regeneration from seed (**Plate 2**). By the October 2009 assessment, many had returned to their dormant condition. Whilst common on the analogue transects, it was yet to colonise many of the rehabilitated areas.



Plates 1 & 2: *Astrebla pectinata* (barley Mitchell grass) in January 2009 that had both re-sprouted from existing dormant butts (left) and recruited from seed (right). (Photographs by David Hunt, 2009)

***Dactyloctenium radulans* (button grass):** This is an annual grass which responded well to the summer rain and had established on much of the Beverley rehabilitation, setting much seed in the process, accumulating against obstacles and become incorporated into the soil surface since. Some individuals, though desiccated and at the end of their life cycle (it is unlikely these grasses will survive the summer), had retained their structure, and due to their overall contribution to cover values, were included in the 2009 plant assessment.

***Tribulus* spp. (caltrop):** The *Tribulus* genus comprises numerous similar and closely related species. Among them is *Tribulus terrestris*, an introduced species, and a rapid coloniser of disturbed areas, though often considered naturalised in Australia (Hussey et al., 2007). It is a spreading, prostrate annual, but due to its overall contribution to cover values and capacity to trap and accumulate resources within its branch structure, this species was included in the 2009 plant assessment.

***Salsola tragus* (roly poly):** This species has recently undergone a taxonomic revision and was previously known as *Salsola kali* (Florabase, 2009). Originally an introduced species to Australia, it is now widely regarded as a naturalised species (Hussey et al., 2007). It is a rapid coloniser of disturbed areas and was one of the first species to establish on rehabilitation sites at Beverley. A short-lived species, many individuals noted in 2009 were dead and had blown in, as per its method of dispersal (Kutsche and Lay, 2003). The remains of juvenile individuals were common throughout, but this species was not included in the 2009 plant assessment.

***Malvastrum americanum* (malvastrum):** A short-lived perennial, this is an introduced species, often considered naturalised in this part of Australia, with Badman (2008) not considering it as an alien species. It was present adjacent to some of Beverley's drainage lines and more-permanent soaks, though wasn't present at any of the rehabilitation sites.

3. RESULTS AND DISCUSSION

3.1 Analogue Transects – Mitchell Grass Upland Plains

3.1.1 Site Description

Two analogue transects (EFA02 and EFA03) were located on the Mitchell grass upland plains to the south-west of the processing plant and well fields. Established in 2006, EFA02 (**Plates 3-4**) is on the upper reaches of a gently sloping rise, approximately 1 km south-west of the processing plant. Transect EFA03 (**Plates 5-6**) is 2 km to the west of the processing plant on a gentle sloping plain.

The upland plains land unit is characterised by gentle to steeply-sloped dissection slopes generally between elevations of 80 to 110 m (Beverley Uranium Mine EIS, 1998). The analogue sites consist of gibber / cracking clay with gilgai patterning, and soils that are typically red-brown, silty clays. The cracking 'puffy' brown clay within the gilgai complexes often forms a depression or sink, known as crabhole formations, ranging in depth from 0.3 to 0.7 m. Vegetation associated with the upland plains was dominated by open grasslands of *Astrebla pectinata* (barley Mitchell grass) over a very low open shrubland of *Sclerolaena divaricata* (golden poverty bush).

3.1.2 Landscape Function

The landscape function results for EFA02 remained comparable with those from 2008, whereas all three of the indices at EFA03 improved (**Figure 2**). At EFA03, this was due to improvements in the soil surface characteristics of its 'bare flat' zone, which comprised 70% of the transect, including better formed crusts aiding surface protection. The surface was only lightly crusted, however, and especially those areas where stone cover was absent, were prone to disturbance. The increase in infiltration and nutrient cycling indices occurred as a result of an increase in the vegetation and litter cover following the rains received in the previous December (**Appendix F**). Much of this ephemeral flush, however, had died, broken-up and dissipated since, though litter from *Tribulus* spp. (caltrop) and *Salsola tragus* (roly poly) remained. Soaks and crabholes were the biggest resource capture zones and were accumulating litter and seed resources. At EFA03 some large cracks were appearing in sections. The middle section of EFA02 flattens into sink for shed resources and a soak for water following heavy rain. As a result, a number of crabholes and rills had formed where this overflows onto the surrounding slope. Unstabilised by perennial vegetation, the edges of these features are highly dispersive and could be expanding. The proportion of crabhole formations identified along EFA02 increased since 2008 from 2% of the transect to nearly 8%.

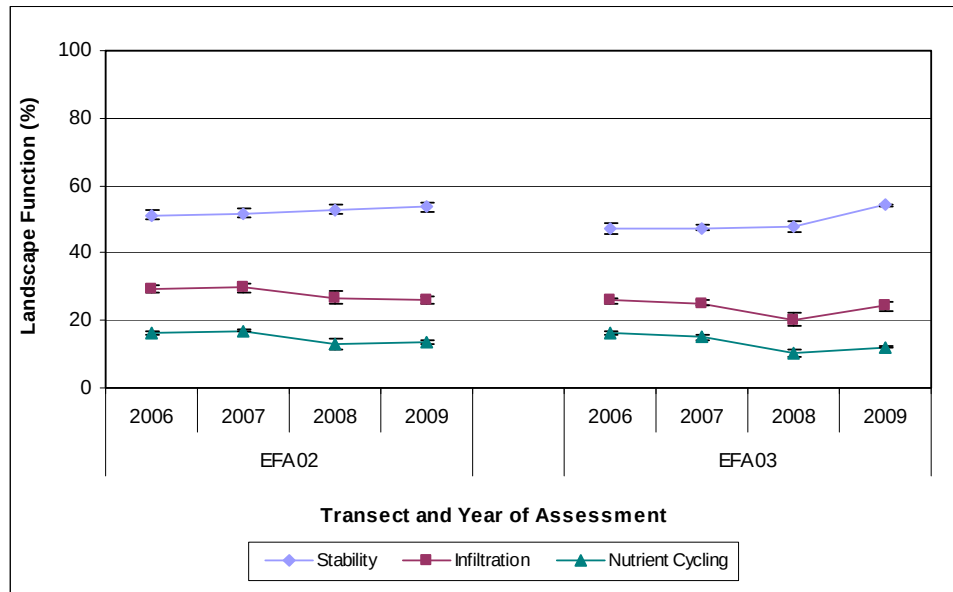


Figure 2: Changes in landscape function of the Mitchell grass upland plains analogue sites

3.1.3 Vegetation Dynamics

The vegetation cover and density of EFA03 remained above that of EFA02 (**Figure 3**). Cover and density remained comparable at EFA02 and was the second lowest of all the Beverley analogues, whereas at EFA03 it increased as a result of the previous summer rainfall (**Appendix F**).

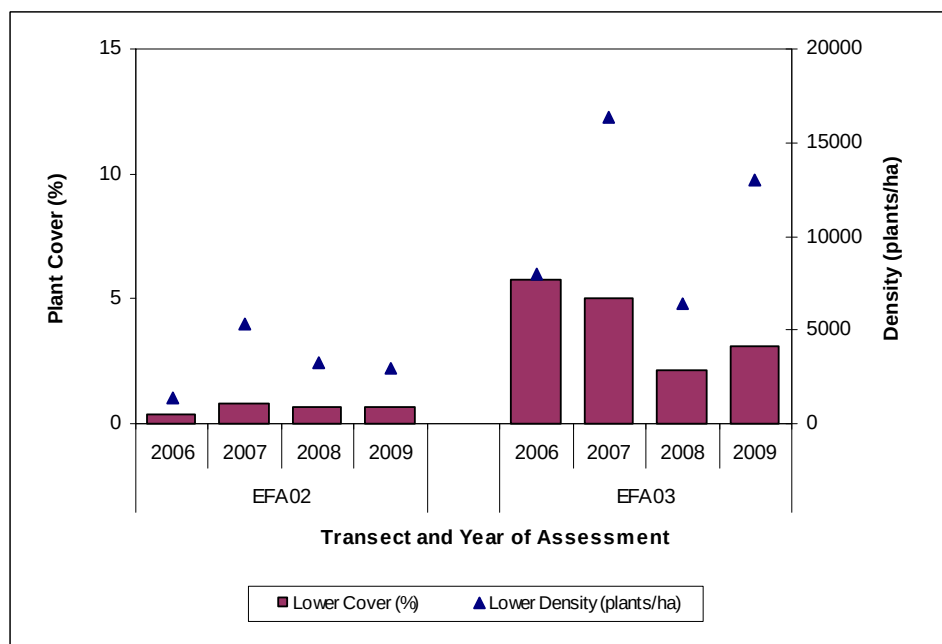


Figure 3: Changes in the plant cover index and density of the Mitchell grass upland plains analogue sites

The number of species present at EFA02 and EFA03 remained comparable with the 2007 and 2008 assessments (**Table 2**). They comprise mostly of short-lived species, many in a desiccated and dehydrated state or approaching dry-period dormancy, such as the *Sclerolaena* species. *Astrebla pectinata* was the only long-lived perennial species occurring at either transect and comprised 40% of the plants recorded in 2009. While mostly consisting of dry stalks lacking photosynthetic material, *A. pectinata* is known to recover given favourable conditions and at least a proportion of them are expected to regenerate under such circumstances. One *Senna* sp. (cassia), 60 cm in height was present 10 m from the end marker of EFA03, but was in poor condition.

Table 2 Average number of species present at upland plain analogues

Year of Assessment	2006	2007	2008	2009
Average Uplands Analogue	5	7	7	8

The habitat complexity remained relatively low due to the absence of trees or shrubs on the transects (**Appendix E**), although small terrestrial fauna could inhabit the cracking soils. There was evidence of only minor kangaroo activity at both transects, and included the presence of tracks and scats.

3.1.4 Habitat Complexity

The habitat complexity remained relatively low due to the absence of trees or shrubs on the transects (**Appendix E**), although small terrestrial fauna could inhabit the cracking soils. There was evidence of only minor kangaroo activity at both transects, and included the presence of tracks and scats.

3.1.5 Plates



Plates 3 & 4: EFA02 in 2009 at 0 m (left) and end marker (right), is on a slight slope but generally stabilised by stony cover.



Plates 5 & 6: EFA03 in 2009 at 0 m (left) and end marker (right), with some rilling and possible formation of crabholes in the foreground of the right-hand-side photo.

3.2 Analogue Transects – Mitchell Grass Lowland Plains

3.2.1 Site Description

There are three transects (EFA06, EFA11 and EFA19) on the Mitchell grass lowland plains surrounding the Beverley Uranium Mine. Transect EFA06 (**Plates 7-8**) is on the mid slope of a low hill, approximately 700 m south of the processing plant. Transect EFA11 (**Plates 9-10**) is on a gently sloping plain, near the southern borrow pit. Transect EFA19 (**Plates 11-12**) is on a gently sloping plain in the southern section of the main mining lease. These analogue areas are representative of the greater portion of disturbed areas within the mine.

The lowland plains land unit is characterised by gilgai and stony gibber patterning with soils that are generally reddish brown, very silty to sandy clays. Cracking clay gilgai complexes and crabhole formations are consistent with those of the upland plains. Vegetation associated with the lowland plains is dominated by open grassland of *Astrebla pectinata* (barley Mitchell grass) over a low open shrubland of *Sclerolaena divaricata* (golden poverty bush). Some of the lower lying regions comprise very low ephemeral herbland of *S. divaricata* and *S. ventricosa* (salt copperburr)..

3.2.2 Landscape Function

Most landscape function indices increased since the 2008 assessment (**Figure 4**). The largest increase was for the infiltration and nutrient cycling indices of EFA19. This was due to an increase in the proportion of 'patch' zones along the transect, comprised of litter flats, which increased from 2% to 14% between assessments, more than for the other lowland analogues. This also increased the resource capture potential of wind-blown sediment, litter and seed material. The topsoil of most transects retained much organic material (roots) from the summer ephemeral growth, even where above surface material had already dissipated.

EFA06 had the highest stability index of the lowland analogues, due to approximately 71% of the transect comprising of soils with some protective contribution from stony material (as opposed to only 45% at EFA11 and 18% at EFA06). EFA06 also recorded sections with stable cryptogam crust. The areas unprotected by this cover generally comprised of bare puffy soils, with thin, though easily disturbed, surface crusts.

Crabholes were present at all three transects, which also had naturally-forming large, deep cracks through the soft and highly dispersive sub-surface. These features did not appear to have increased between assessments, with a similar proportion of each transect being occupied by related zones. At EFA19 some had filled with sediment and litter resources, with most vegetative growth at this transect confined to these areas.

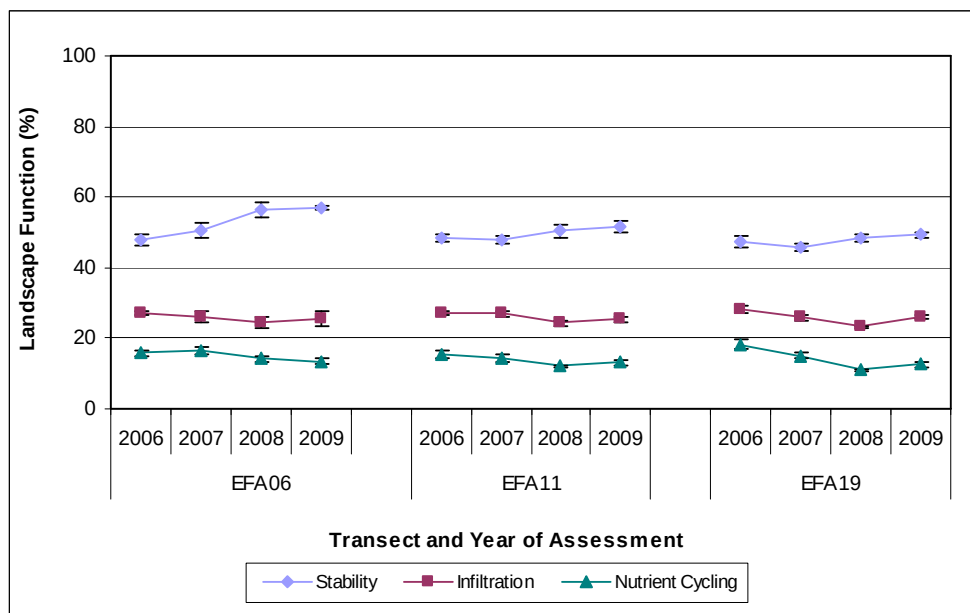


Figure 4: Changes in landscape function of the Mitchell grass lowland plains analogue sites

3.2.3 Vegetation Dynamics

Cover and density values for all three transects improved since the 2008 assessment (**Figure 5**). The plant density at EFA11 and EFA19 underwent large improvements due to the recruitment of short-lived *Sclerolaena* species and grasses following the December rainfall (**Appendix F**), but these were only of small crown-size (averaging 10cm), with the cover value remaining below 3% for all transects. This did however signify the presence and viability of seed resources in the topsoil. As is typical of these opportunistic species, there is expected to be a low rate of survivorship, with many individuals already having senesced or showing signs of desiccation and dieback.

A comparable number of species were present at each transect compared to previous assessments (**Table 3**). The assemblage at EFA06 was dominated by species of *Sclerolaena*, and had the lowest cover of any analogue, owing to the relative absence of grass species from along the transect. The other two transects had a larger grass contribution with 61% of plant records at EFA11 being either *Eragrostis eriopoda* (woollybutt) or *A. pectinata* and 69% of EFA19 comprising *Dactyloctenium radulans* (button grass) and *A. pectinata*. Many *E. eriopoda* had re-sprouted from mature dormant butts. Some *A. pectinata* appeared to have established from seed, with a number of small individuals recorded. An increase in the prostrate *Tribulus* spp. (caltrop) also contributed to cover values. Some litter was provided by *Salsola tragus* (roly poly) and live individuals were also present at EFA11 and EFA 19.

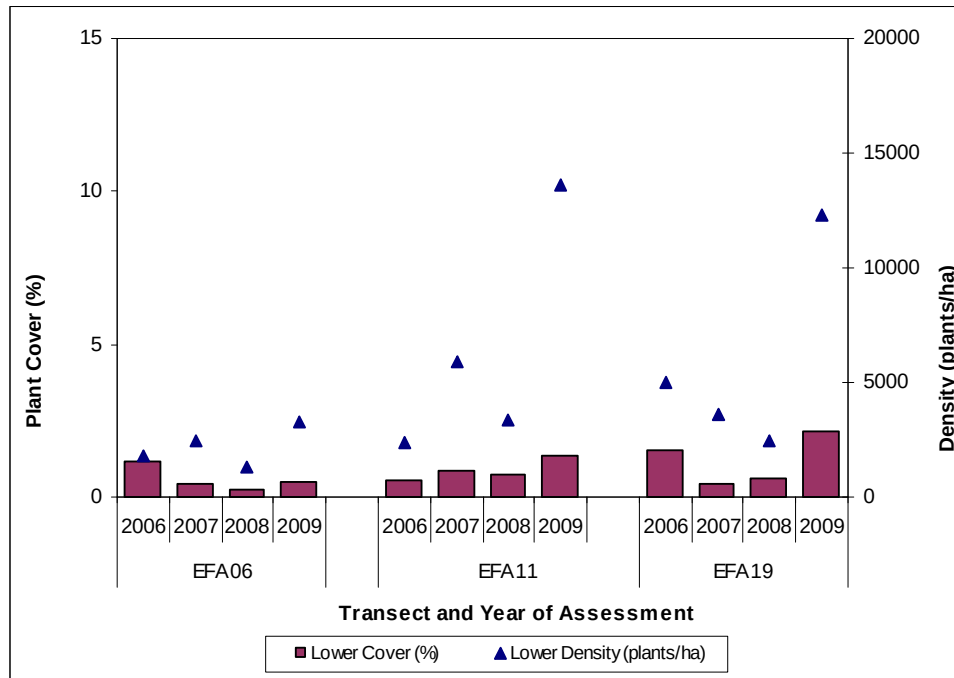


Figure 5: Changes in the plant cover index and density of the Mitchell grass lowland plains analogue sites

Table 3: Average number of species present at lowland plain analogues

Year of Assessment	2006	2007	2008	2009
Average Lowlands Analogue	6	7	8	8

3.2.4 Habitat Complexity

The habitat complexity of the Mitchell grass lowland plains remained relatively low (**Appendix E**). The absence of mature trees or shrubs reduced the availability of faunal niches although the cracks and crabholes could provide refuge for small fauna. Suspected small-mammal and possible goanna scratchings were observed at EFA19, and spider holes at EFA06 signified the presence of invertebrates. There was also evidence of kangaroo activity at all three transects.

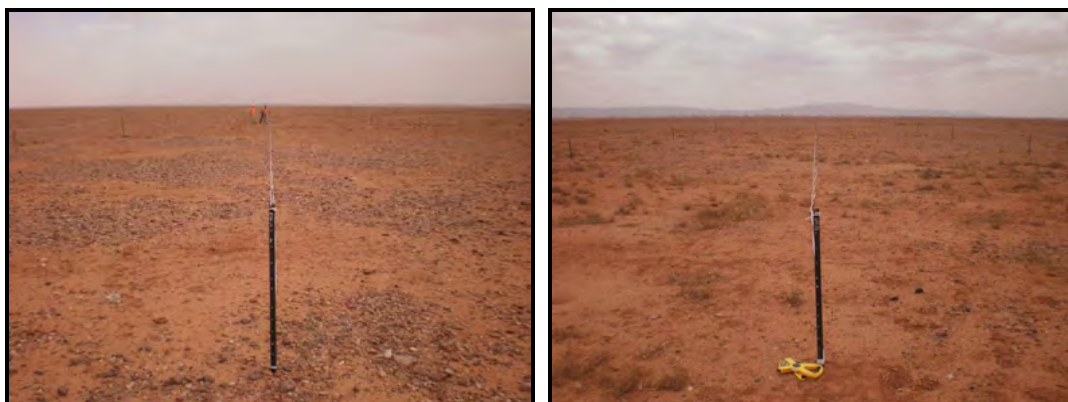
3.2.5 Plates



Plates 7 & 8: EFA06 at 0 m (left) and end marker (right) with varying levels of stone cover.



Plates 9 & 10: EFA11 at 0 m (left) and end marker (right) showing alternating stony and bare patches along transect.



Plates 11 & 12: EFA 19 at 0 m (left) and end marker (right) is the longest analogue, 100m across *Astrebla pectinata* plain.

3.3 Analogue Transects – Minor Creeks and Drainage Lines

3.3.1 Site Description

Four transects (EFA04, EFA07, EFA09, EFA15) were established in 2006 in the minor creeks and drainage lines that dissect the Mitchell Grass Plains throughout the Beverley area (**Plates 13-20**). Transect EFA04 was in the upper section of the Jenny Creek (northern arm) approximately 400 m upstream (north-west) of the processing plant. Transect EFA07 was located in the lower reaches of Jenny Creek (northern arm), approximately 600 m downstream (east) of the processing plant. Transect EFA09 was in a central region of the Northern Creeklet, and transect EFA15 was a further 600 m downstream on the outer edge of this drainage feature. Considerable drilling activity had occurred within close proximity to analogue Transects EFA09 and EFA15. The 0-10 m section of EFA 15 was recovering from related disturbance and was not included in data analysis for this transect.

There were two main classes of alluvial soils within the creeks and drainage lines; the very recent and re-worked clean sand and gravel deposits of the major channels; and the finer sand and alluvium deposits on the levees and adjacent flats. Vegetation within the minor creeklines was characterised by a tall open shrubland dominated by *Acacia tetragonophylla* (dead finish), *A. victoriae* (elegant wattle), *Eremophila duttonii* (harlequin fuchsia bush) and *E. freelingii* (rock fuchsia bush) over a low open shrubland of *Maireana aphylla* (cottonbush) and *Senna* spp. (cassia) with an understorey of *Astrebla pectinata* (barley Mitchell grass) and *Sclerolaena* spp. (copperburr).

3.3.2 Landscape Function

Most landscape function indices were comparable with previous years of assessment (**Figure 6**), although EFA15 was the only transect where all indices had improved. The stability index for EFA15 was higher than at other transects, due to it being the only transect that didn't occur in the less-stable and often uncrusted creek-bed. Surface crusts, where present, remained quite fragile and brittle. EFA09 is near the site of other monitoring activities (bore monitoring, fauna transects), and at this transect the crust had been recently disturbed, though not severely, by foot traffic.

There was some erosion that resulted from the flow of water at the creekline transects. At EFA04, which had the steepest slope of any of the analogues, there was some rilling into the catchment, with approximately 2% of the transect classified as thus. In addition, a rill appeared to be forming in a kangaroo pad beyond the 50 m marker post. At other creekline transects, there was deposition of sediment and litter on flow-side facing obstacles. At EFA07, this resulted in 30 cm high hummocks around some shrub bases. Pedestalling was also common, and at some transects, root material had been exposed through the weathering of surrounding sediment.

An increase in the availability of litter since the 2008 assessment, contributed to an increase for most infiltration and nutrient cycling indices. This included log and stick material, leaf drop from trees, dead grasses, and the remains of forbs and herbs that had recruited following the December rain event (**Appendix F**). Root biomass

of ephemeral plants remained integrated with the surface, even after the above-surface portions had broken down and dissipated.

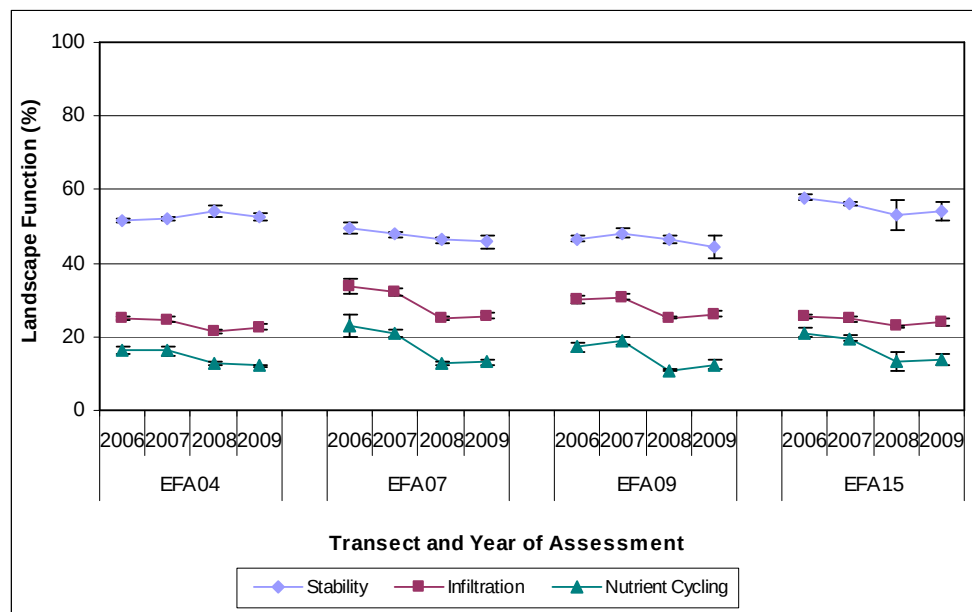


Figure 6: Changes in landscape function of the minor creek and drainage line analogue sites.

3.3.3 Vegetation Dynamics

The cover and density values for all transects improved since the 2008 assessment (**Figure 7**) due to the presence of residual herbage and growth from the December rains. Overall, the transects supported three of the highest cover and densities of any transect at Beverley. The exception was EFA04, due to it running cross-wise against the creek, as opposed to along it as at EFA07 and EFA09. The largest increase in plant cover was recorded at EFA15 where the cover value increased from 19% to 77% and the density increased by more than seven times due to the recruitment of grasses. In 2008, the proportion of records that were woody shrub species was 60%, with the remaining 40% comprising of *Sclerolaena* species. In 2009, only 16% of the plant records were woody shrubs, and only 25% were *Sclerolaena* species, the rest being comprised mostly of other grass species. Similar increases in plant density were recorded for the other transects and occurred as a result of the increased occurrence of *Dactyloctenium radulans* (button grass) and *Tribulus* spp. (caltrop). Around 80% of EFA09 now comprised of grasses (*D. radulans* and *A. pectinata*) compared with only 14% in 2008.

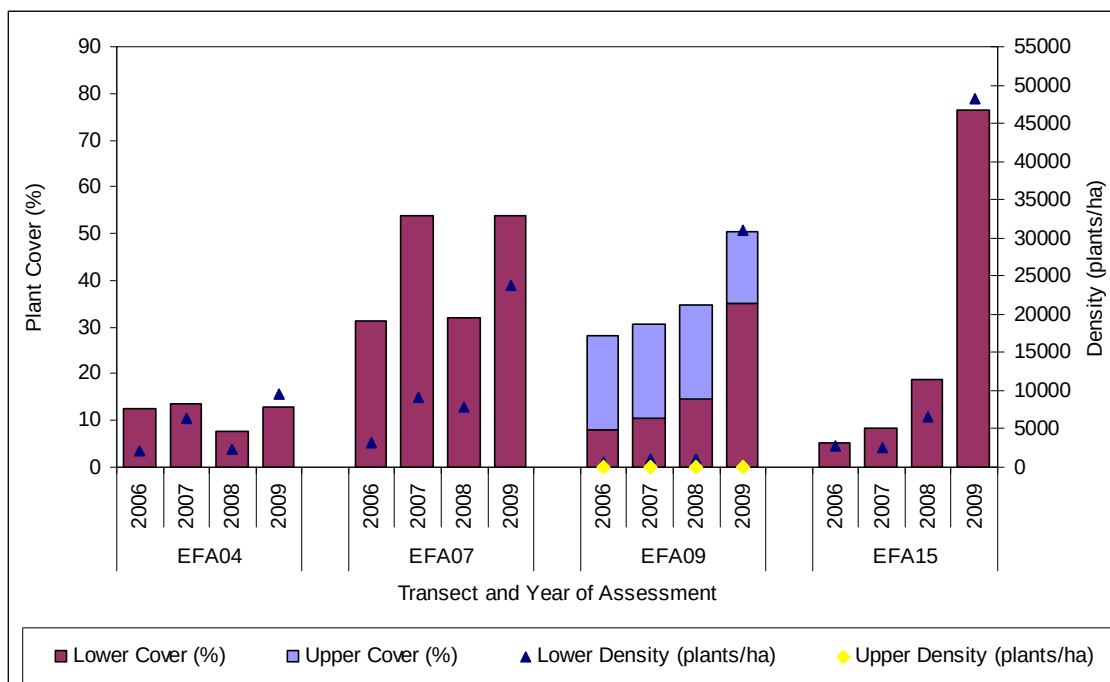


Figure 7: Changes in the plant cover index and density of the minor creek and drainage line analogue sites

EFA09 was the only transect at Beverley which recorded an upper storey. Here it comprised almost solely of *Acacia tetragonophylla*. As only trees greater than 3 metres in height were sampled in the overstorey assessment, over 350 m had to be traversed to sample enough individuals to produce a statistically valid result (25 individuals). This meant that the data-set represented an area much broader than that immediately adjacent the 50 m transect. In 2006 and 2007, the overstorey was not considered significant enough to warrant independent assessment using the Wandering Quarter method, and in **Figure 7** the 2006 value has been replicated. Consideration should be given to changing the method of monitoring overstorey at this transect, as the quality of results was affected by the average 30 m distance between individuals, introducing a larger degree of error. Many of the individuals sampled had undergone significant leaf drop and some contained senescent branches that had broken down or were totally devoid of photosynthetic growth. Reducing the monitoring height to 2 m would include a larger number of samples within the actual transect area.

The creekline analogue transects recorded the highest species richness of Beverley sites (**Table 4**). EFA04 and EFA15 had the highest individual richness with 11 species recorded along each of their transects. This often included an upperstorey, of approximately 2 m in height, comprising of species not present on the upland and lowland plain analogues, such as *Hakea leucoptera* (needlewood) at EFA04, *Santalum lanceolatum* (plum bush) and *Senna* sp. (cassia) at EFA07, and *Acacia tetragonophylla* at EFA09. The perennial shrub layer comprised mostly of *Maireana aphylla* and *Rhagodia spinescens* (spiny saltbush), but for many of them leaf drop and defoliation had occurred. Among other species recorded were *Eremophila freelingii* (rock emubush) near EFA07 and *Senecio magnificus* (showy groundsel) adjacent EFA09.

The relative proportions of these woody species sampled along the transects had declined, due to the increased presence and recruitment of grasses and *Sclerolaena* species. At least five species of grass were present at EFA15; *Aristida contorta* (kerosene grass), *Astrebla pectinata* (barley Mitchell grass), *Eragrostis eriopoda* (woollybutt) and *Sporobolus actinocladus* (katoora). In addition to those grasses, *Cymbopogon* sp. (lemon-scented grass) and *Danthonia caespitosa* (wallaby grass), were identified near EFA07. Some remains of *Salsola tragus* appear to have blown into transect areas, such as at EFA09, as per their typical method of dispersal.

Cucumis spp. (paddy melon) and *Malvastrum americanum* (malvastrum) both occurred near EFA15 and the *Malvastrum* was also identified near EFA07. These species were in low concentration and as annuals, undergo dieback during dry periods.

Table 4: Average number of species present at drainage line analogues

Year of Assessment	2006	2007	2008	2009
Average Creek and Drainage Line Analogue	8	9	8	9

3.3.4 Habitat Complexity

The habitat complexity remained the highest of any Beverley transects (**Appendix E**), on account of additional faunal niches provided by the established shrub and tree layers. Kangaroo impact was present at all four transects and included scratchings and cleared areas where they had camped. It was higher than for other analogues due to the better cover and shade afforded by the woody perennial dominants. None of the creeklines held water at the time of assessment (nor since the January rains), with larger water-dependent fauna such as kangaroos, probably relying on mine-related water sources. Rabbit scats were also frequently observed with many of the soft soils suitable for the digging of warrens and burrows. Small fauna appeared abundant at EFA07 where there were numerous tracks and burrows. Ant lion nests were also common on sandier zones in many of the creekline analogues including EFA07 and EFA09, signifying the presence of invertebrate prey, although few were sighted at the time of assessment.

3.3.5 Plates



Plates 13 & 14: EFA04 in 2009 at 0 m (left) and end marker (right) dissects the creekline perpendicular to the direction of flow.



Plates 15 & 16: EFA07 in 2009 at 0 m (left) and end marker (right), with low shrub cover dominated by *Senna* sp. (cassia)



Plates 17 & 18: EFA09 at 0 m (left) and end marker (right) is the only transect with a developed overstorey, comprising of scattered *Acacia tetragonophylla* (dead finish)



Plates 19 & 20: EFA15 at 0 m (left) and end marker (right) is located on a minor drainage line. The disturbance at the front of the transect can be seen on the left-hand-side photograph.

3.4 Analogue Transects – Four Mile Creek Floodplain

3.4.1 Site Description

Transect EFA12 is on the floodplain, 450 m south of Four Mile Creek and 2.4 km north-east of the processing plant. The floodplain in this area has stony gibber / gilgai patterning, similar to the Mitchell Grass Plains. It also has extensive areas of scalding where the upper silty or sandy horizon has been removed, exposing an impermeable clay surface (Beverley Uranium Mine EIS, 1998). Vegetation on this section of the floodplain is sparse, and comprises open grassland of Mitchell grass over a low very open herbland of mixed *Sclerolaena* spp. and *Dissocarpus paradoxus* (cannonball) (**Plates 21-22**).

3.4.2 Landscape Function

The landscape function indices remained comparable between 2008 and 2009 assessments (**Figure 8**). The proportion of litter zones and hummocks recorded along the transect improved, possibly due to the accumulation of litter and sediment against biomass that had resulted from the December rains. There was a considerable contribution to subsurface stability by root material originating from this ephemeral flush of vegetation. There were numerous crabholes, but the proportion of the transect classified as thus remained at approximately 7%. The soil surface characteristics were variable along the transect depending on the presence or absence of stony cover of cryptogam crusts.

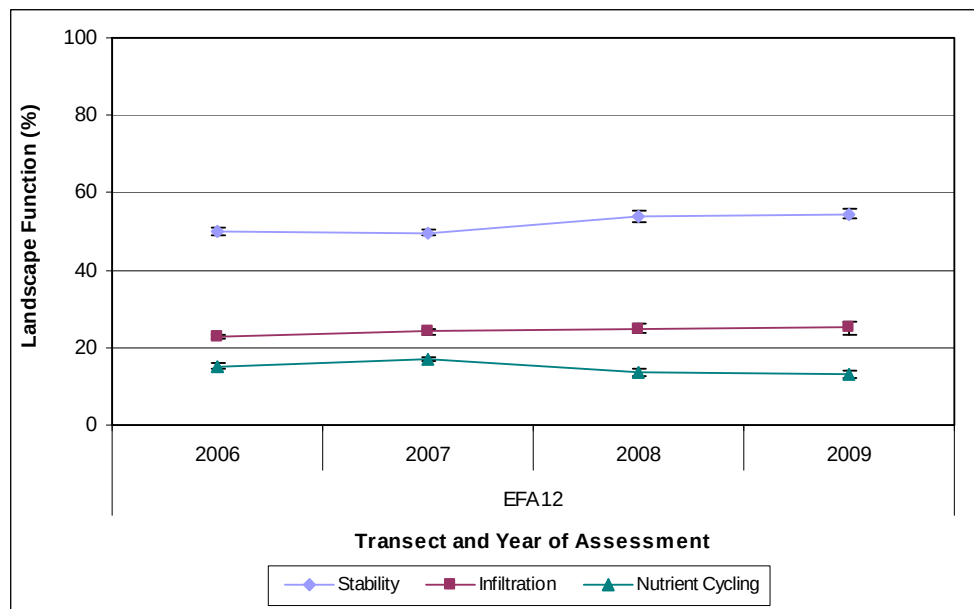


Figure 8: Changes in landscape function of the Four Mile Creek floodplain analogue sites

3.4.3 Vegetation Dynamics

Vegetation cover remained low but consistent with previous assessments (**Figure 9**), although it was one of the few transects where the cover value actually decreased. This was due to the *Dactyloctenium radulans* (button grass) and *Tribulus* spp. (caltrop) that contributed to much of the cover increases observed at other transects,

being absent or sparse at EFA12. Plant density improved slightly but comprised mostly of small-crowned and short-lived individuals.

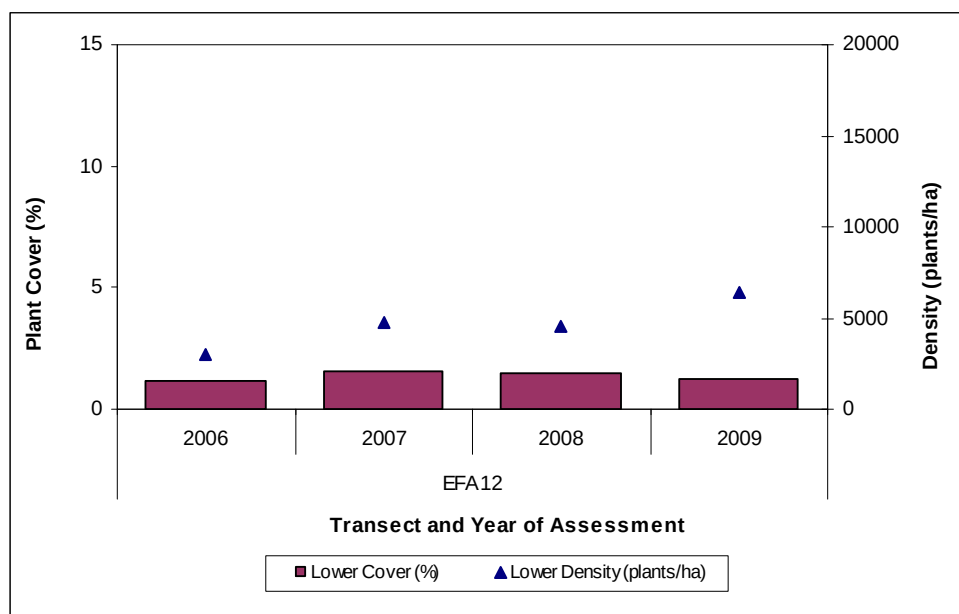


Figure 9: Changes in the plant cover index and density of the Four Mile Creek floodplain analogue sites

The number of species recorded along the transect remained comparable to results achieved in 2007 and 2008 (**Table 5**). There were fewer grasses than at other transects, including only sparse *Astrebula pectinata* (barley Mitchell grass), with the assemblage dominated by *Sclerolaena* species.

Table 5: Number of species present at the flood plain analogue

Year of Assessment	2006	2007	2008	2009
Floodplain Analogue	4	7	9	8

3.4.4 Habitat Complexity

The habitat complexity of the Four Mile Creek Flood Plain Analogue remained low (**Appendix E**) due to the absence of tree or shrub vegetative layers. The surface, however, bore the evidence of small-fauna utilisation in the form of scratchings and burrows. Invertebrates were also present and included spider holes. Both rabbit and kangaroo scats were recorded, but while the surface crust was often broken, it had not been severely impacted by kangaroo activity. Kangaroos appeared to favour the nearby (immediately adjacent) rehabilitated areas over the analogue zones, possibly due to softer surface material or fewer prickles and burrs in the later.

3.4.5 Plates



Plates 21 & 22 EFA12 at 0 m (left) and end marker (right), which comprised of bare and stone-covered zones, though with limited perennial vegetation development on either.

3.5 Analogue Transects – Expansion Areas

3.5.1 Site Description

Two analogue transects (**Plates 23-26**) were installed during the 2008 assessment to represent areas of possible future expansion. EFA26 is approximately 3.8 km south east of the processing plant in Zone 3 of the Beverley East expansion area. It slopes gently to the south and occurs on a puffy clay outwash with light stone cover. The surrounding vegetation assemblage was dominated by *Maireana aphylla* (cottonbush), *Astrebla pectinata* (barley Mitchell grass) and various *Sclerolaena* (copperburr) species.

Transect EFA27 is approximately 11km northwest of the Beverley processing facility near the Four Mile prospect area west of the Four Mile mining lease application. The transect is 500 m inside the Arkaroola fenceline on a gently sloping foothill of the Flinders Ranges. It has a well-crustured stony surface and was dominated by a mid-shrub layer of *Eremophila duttonii* (harlequin fuchsia bush), *Hakea leucoptera* (needlewood) and *Senna* sp. (cassia). *Sclerolaena longicuspis* (long-spined poverty bush) was well-represented in the under storey. Both analogue transects had been fenced and signposted since the 2008 assessment to prevent possible future disturbance.

3.5.2 Landscape Function

The landscape function indices for both transects remained comparable between assessments (**Figure 10**). EFA26 had a much larger ephemeral herb response than EFA27 following the December rainfall event (**Appendix F**), but despite an increase in litter at the 2009 assessment, there was little improvement in the indices, particularly for infiltration and nutrient cycling. There were numerous crabholes and cracks with some erosion of soft underlying material. Litter and sediment had accumulated in these zones, forming a medium for future plant establishment and growth. The surface itself was well crusted, with considerable incorporation of root structures and biomass from the post-rainfall flush of vegetation. The crusts however were thin and easily disturbed by both foot traffic and the erosive forces of wind and rain. Loose sediment and material had accumulated around some plant bases, and pedestalling had occurred around dormant *Eragrostis* sp. (lovegrass) bracts.

EFA27 had the highest stability and nutrient cycling indices of any Beverley transect. The high stability index was supported by a significant cryptogam contribution, particularly around plant bases, which may provide a micro-climate for their establishment. Leaf drop and dieback were contributing to an increase in litter layers which resulted in a slight increase of the infiltration and nutrient cycling indices. The proportion of resource accumulating zones (comprising of plant and litter patches) along the transect had doubled between 2008 and 2009 assessments from 3% to 6%.

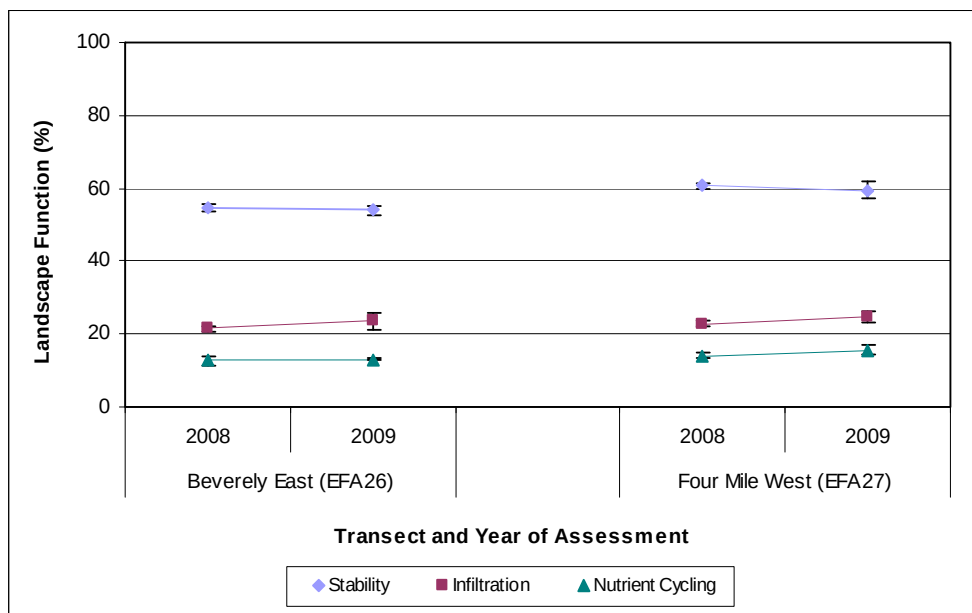


Figure 10: Changes in landscape function of the Beverley East (left) and Four Mile West (right) analogue sites

3.5.3 Vegetation Dynamics

The plant cover and density values for EFA26 had improved following the post-rain recruitment event, the later improving by more than seven times (**Figure 11**), although most individuals recorded during the 2009 assessment had been severely desiccated, either approaching senescence or returning to states of dormancy. It did however have the highest plant density of any of the analogues. Some of this appeared to be due to the inclusion of numerous *Eragrostis* butts in the vegetation assessment, which may have been considered dead during the 2008 assessment, but had regenerated (and were even seeding) following the December rainfall. There were also numerous senescing *Dactyloctenium radulans* (button grass) individuals, the numerous seeds of which were accumulating around plant bases. As a result, the number of woody shrubs (*Maireana aphylla*) recorded along the transect had declined from 13 to just 3.

The increase observed at EFA27 was less distinct. It had the lowest plant density of any of the analogues, and had fewer grasses than most other transects. The average diameter of plants recorded along the transect decreased from 57 cm to 36 cm, due to the colonization of the smaller *Sclerolaena* species following the summer rains. In 2008, 59% of the plant records were of established woody perennials, whereas in 2009 this had reduced to 25% in favour of smaller-crowned, shorter-lived herbs.

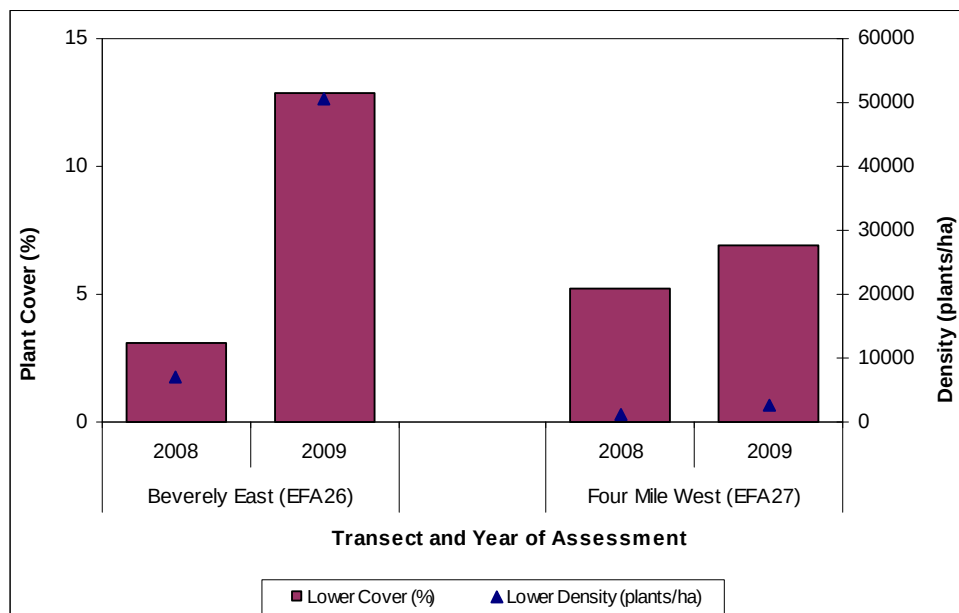


Figure 11: Changes in the plant cover index and density of the Beverley East and Four Mile West analogue sites

The number of species recorded along both transects improved since 2008, particularly at EFA26 (**Table 6, Appendix D**). Species present at the small soak adjacent EFA26 included *Acacia victoriae* (elegant wattle), including some dead individuals, *Rhagodia spinescens* (spiny saltbush) and *Senna* sp. (cassia). Also present nearby were *Cucumis* sp. (paddy melon) and *Malvastrum americanum* (malvastrum), but neither remained alive following the dry period preceding the assessment.

Table 6: Number of species present at expansion analogues

Year of Assessment	2008	2009
Beverley East Analogue	6	9
Four Mile West Analogue	8	9

3.5.4 Habitat Complexity

Habitat complexity remained higher at EFA27 due to its better-developed shrub layer and a larger number of faunal niches (**Appendix E**). Invertebrate fauna was present at both sites, however, and included spider-holes at EFA26 and abundant ant activity at EFA27. Kangaroo tracks and scats were present at both transects, however there was little grazing noted. Evidence of historic cattle occupation, through the presence of scat, remained at EFA26. There was a small soak within 50 m of EFA26 that retains water for short periods following rainfall. The immediate area contained larger amounts of litter and ephemeral biomass as a result. Shield shrimp were observed in this soak following the December rainfall event (David Hunt pers. comm.). A small soak was also present near the upper section of EFA27, and the surrounding area also contains numerous temporal creeklines, draining from the nearby Arkaroola foothills.

3.5.5 Plates



Plates 23 & 24: EFA26 at 0 m (left) and end marker (right), with little stone cover and sparse *Maireana aphylla* (cottonbush) shrub layer.



Plates 25 & 26: EFA27 at 0 m (left) and end marker (right), showing *Eremophila duttonii* (harlequin fuchsia bush) and *Hakea leucoptera* (needlewood) shrub layer.

3.6 Rehabilitated Landforms (Airlift Pit, Clay Batching Pad, Borrow Pit)

3.6.1 Site Description

Three rehabilitated landforms were assessed in the 2008 monitoring program (**Plates 27-32**).

Airlift Pit – 2003 Rehabilitation

The Airlift Pit (EFA01) is east of the southern Beverley laydown yard, approximately 900 m south of the processing plant and was rehabilitated in 2003. The landform encompasses an area of ~0.3 ha and has a slightly dome-shaped structure. The area had been lightly ripped and fenced to minimise further disturbance from mining traffic. The landform had not been seeded, to allow a trial of the potential for natural colonisation from local vegetation. The landform occurs in a similar landscape position as the two Mitchell Grass Upland Plains analogue sites and subsequently EFA data collected from these analogues has been averaged and compared with this rehabilitation.

Clay Batching Pad – 2005 Rehabilitation

The Clay Batching Pad (represented by transect EFA05) is directly east of the processing plant and evaporation ponds. The landform encompasses an area of ~0.33 ha and was rehabilitated in 2005. The area was lightly ripped, though not seeded. The area was considered to be within the Mitchell Grass Lowland Plains and therefore comparisons are made with EFA data collected from the three Lowland analogue sites.

Calcrete Borrow Pit – 2007 rehabilitation

The Calcrete Borrow Pit is located approximately 25 km south of the main mining operation and was rehabilitated in 2007, with transect EFA25 installed during the same year. The soils were dominated by rocky limestone material. The area had been reshaped, but ripped vertically, instead of horizontally, which would have provided more zones for resource capture. The area was not seeded. EFA25 is the only transect not occurring in the Mumpie land system. The Borrow Pit occurs in the Munyalina land system of the Flinders Ranges foothills. It was characterized by low calcareous hills and dominated by *Eucalyptus gillii* (curly mallee), *Acacia victoriae* (elegant wattle) and *A. tetragonophylla* (dead finish).

3.6.2 Landscape Function

Many of the indices improved between 2008 and 2009 assessments (**Figure 12**), with vegetation being recorded for the first time at EFA05 (Clay Batching Pad) and EFA25 (Calcrete Borrow Pit).

The bank and trough formations of EFA01 and EFA05 had continued to flatten, with it becoming more difficult to distinguish between the zones. The capacity for the trough structures to capture and retain resources, however, contributed towards EFA01 having the highest infiltration index of any Beverley transect. When compared with the analogue transects, which comprised less than 10% of functionally-similar depressions and crabholes, EFA01 and EFA05 had a much larger proportion of resource-accumulation zones, 70% and 54% respectively. EFA05 retained a greater proportion of its original ripped structure, due to a portion of the transect being integrated with a white, calcrete material, exhibiting better resistance to disturbance than the clayey-soil components of EFA01.

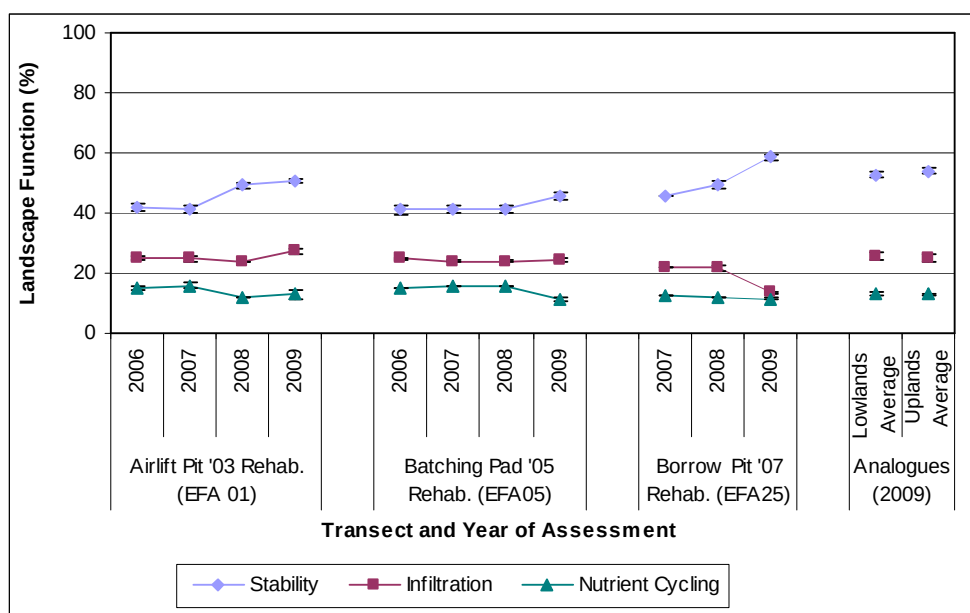


Figure 12 Changes in landscape function of the rehabilitated Airlift Pit, Clay Batchling Pad and Calcrete Borrow Pit

Some crabholing was continuing at EFA01, and the surface was easily disturbed. The thin crust at EFA05 was easily separated from the loose underlying topsoil material. Despite this, the occurrence and stability of physical crusts had improved since 2008.

One of the largest changes in value was a reduction of the infiltration index at EFA25 (Calcrete Borrow Pit), which occurred on account of the hardening surface inhibiting the penetration of water, which instead runs off onto the flat area below the base of the transect. The hardening of the surface, however, did contribute towards the improvement observed for the stability index of the same transect. Some sediment had washed downslope and had been captured by larger rocks on the lower slope. There was no appropriate analogue to compare against EFA25, and consideration could be given to installing a representative analogue site during future assessments.

3.6.3 Vegetation Dynamics

Plant cover and density improved for all three transects, and included the first vegetation assessment for EFA05 (Clay Batchling Pad) and EFA25 (Calcrete Borrow Pit) (**Figure 13**). The shrub density value for EFA01 was nearly 33 times higher than for the 2008 assessment, due to the recruitment of small-crowned, short-lived plants (with an average diameter of 5cm) after the summer rainfall event. This exemplified the availability of seed resources (particularly *Sclerolaena brachyptera* and *Salsola tragus*) in the topsoil, as the landform had not been specifically seeded. In 2008, the average distance of plants from the transect was 3.5 m, whereas in 2009 it was just 60 cm. The density value for EFA01 was the only vegetation parameter to exceed the analogue levels.

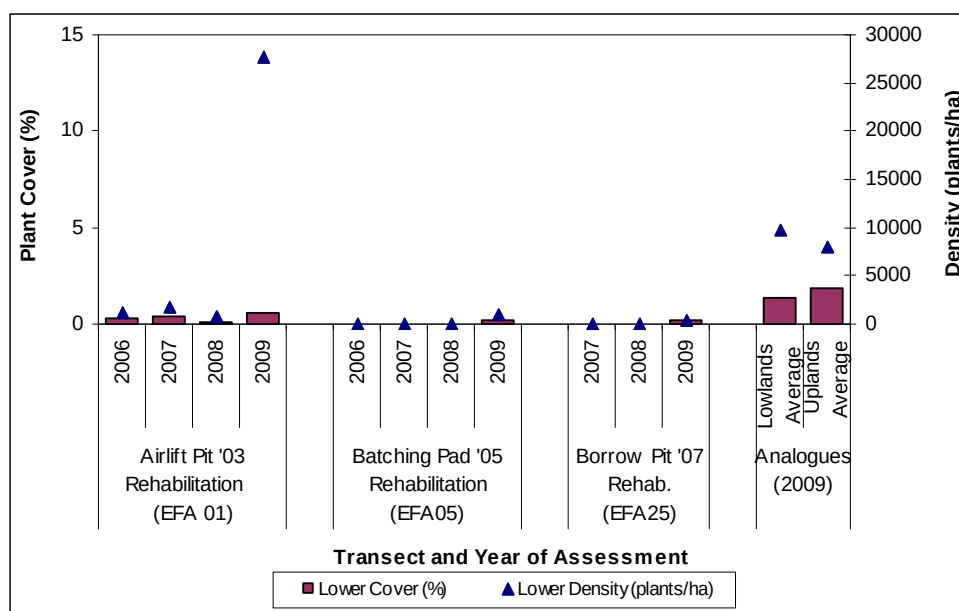


Figure 13: Changes in the plant cover index and density of the rehabilitated Airlift Pit, Clay Batching Pad and Calcrete Borrow Pit

Encroachment of vegetation from the surrounding un-disturbed communities at EFA05 was occurring, though comprised mostly of coloniser species such as *Tribulus* spp. (caltrop), which made up 38% of the records, and *Salsola tragus* (roly-poly). EFA05 had the lowest cover value of any Beverley transect.

Growth at EFA25 was mainly confined to the lower sections where seed and sediment resources may have accumulated after being washed downslope. This transect had the lowest density of any Beverley rehabilitation most likely due to the hardened surface impeding the penetration of root structures. Among the species sampled along this transect, however, was a young *Acacia victoriae* (elegant wattle) individual that had colonised the mid-slope. This was the only rehabilitation monitored at Beverley to support an *Acacia* species.

The number of species recorded at EFA01 (Airlift Pit) remained comparable to the 2008 result (**Table 7**). Whilst being dominated by short-lived colonisers, this rehabilitation also included the perennial grass *Astrelba pectinata* (barley Mitchell grass), which was yet to occur at EFA05.

EFA25 comprised of species able to tolerate the alkaline calcrete soils including *Sclerolaena obliquicuspis* (limestone copperburr). Also present on the rehabilitation was *Salsola tragus*, *Solanum ellipticum* (velvet potato bush) and a species of *Sida*.

Table 7: Number of species present at rehabilitated landforms.

Year of Assessment	2006	2007	2008	2009
Airlift Pit (2003 Rehabilitation)	5	9	7	6
Clay Batching Pad (2005 Rehabilitation)	*	*	*	5
Calcrete Borrow Pit (2007 Rehabilitation)	*	*	*	6
Average Uplands Analogue	5	7	7	8
Average Lowlands Analogue	6	7	8	8

(* = plant assessment not carried out due to lack of vegetation on landform)

3.6.4 Habitat Complexity

Habitat complexity remained low, but had improved following the minor colonisation of vegetation components (**Appendix E**). The soil surface at EFA01 and EFA05 could provide habitat niches for burrowing fauna, but the hard calcrete nature of EFA25 was less likely to be utilised in such a fashion. At EFA25, invertebrate activity was high under the protective cover of the low shrubs present, and spider holes were noted at EFA01. Kangaroo activity was minimal, but tracks and scats were observed, particularly at EFA05, where they may be attracted by the scent of nearby water at the Beverley plant.

3.6.5 Plates



Plates 27 & 28: EFA01 at 0 m (left) and end marker (right) with establishing, though very low, cover.



Plates 29 & 30: EFA05 (Clay Batching Pad) at 0 m (left) and end marker (right), with kangaroo tracks evident in the left-hand-side photograph.



Plates 31 & 32: EFA25 (Calcrete Borrow Pit) at 0 m (left) and end marker (right) showing minor colonisation.

3.7 Rehabilitated Drill Pads – Mitchell Grass Plains

3.7.1 Site Description

Seven rehabilitated drill sites of various ages (EFA08, EFA10, EFA20, EFA21, EFA22, EFA23, EFA24) (**Plates 33 - 46**) were selected for monitoring within the Mitchell Grass Upland and Lowland Plains environments at Beverley. Different rehabilitation techniques have been undertaken at the mine site within these areas. Through continued monitoring of these sites, EFA data should highlight the various successes and shortfalls of the various techniques used.

2001 Rehabilitation

A number of drill pads rehabilitated in 2001 are located within 1 km north of the processing plant. A single transect (EFA24) represents these older drill pads, which appear to have been lightly ripped during rehabilitation.

2004 Rehabilitation

Three transects (EFA20, EFA21 and EFA22) were established on drill pads which had been rehabilitated in 2004. These drill pads have been re-shaped into slightly domed structures, and lightly ripped on the upper surface to create a bank-trough system.

2006 Rehabilitation

Three transects (EFA08, EFA10 and EFA23) were established on drill pads which had been rehabilitated in 2006. Rehabilitation methodology involved the backfilling of sumps, replacing stockpiled topsoil and re-profiling the upper surface of the pad to blend in with the surrounding Mitchell Grass Plains landscape.

3.7.2 Landscape Function

Most landscape function indices for the three ages of rehabilitation remained comparable with the previous year's monitoring (**Figure 14**). Values were comparable to or approaching the analogue equivalents, and some of the rehabilitation closely resembled the patchiness of the surrounding undisturbed plains, as a result of the establishment of plants in lower lying areas. The stability index decreased slightly for the 2006 rehabilitation, as it lacked a significant contribution from the formation of protective surface crusts or cryptogam cover. The older rehabilitation, performed slightly better in this respect, with better cryptogam cover and thus the stability index tended to improve with age. Surface crusts remained fragile, however, and prone to disturbance. At EFA23 (2006 assessment), the repair (re-crusting) of disturbance caused by foot traffic during the 2008 assessment was observed.

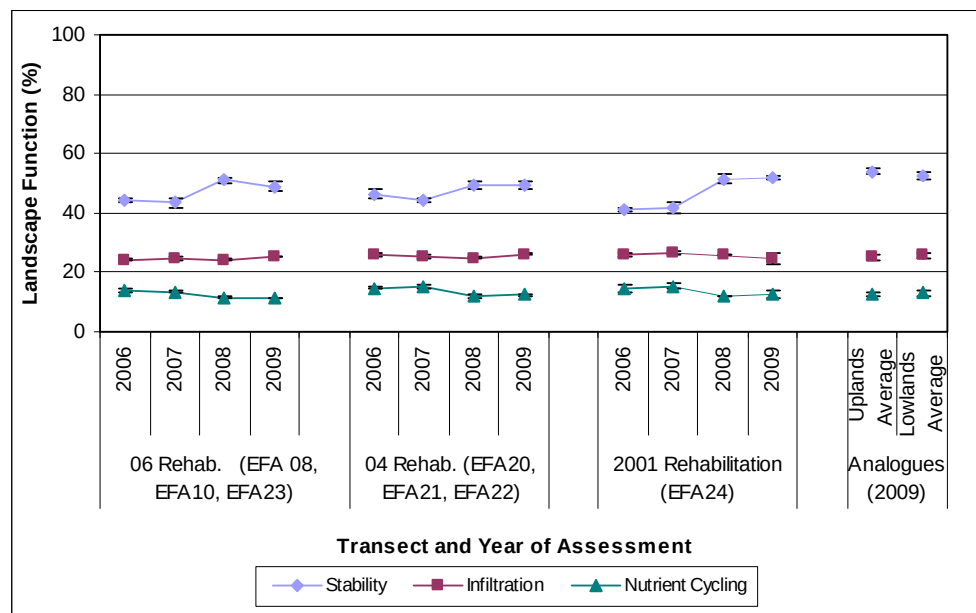


Figure 14: Changes in landscape function of the rehabilitated Mitchell grass plains drill pads

Those transects with higher stability scores tended to have a higher degree of rock integration within the soil, or at least a greater proportion of their length being taken up by such zones. The bank/trough formations at EFA22 (2004 rehabilitation) had retained some structure because of this.

The infiltration and nutrient cycling indices remained comparable between assessments. Despite supporting lower plant cover than the analogues, a larger proportion of the rehabilitated transects comprised of resource-catching troughs and depressions, aiding the infiltration and nutrient cycling indices by acting as a sink for sediment, litter, seed and water resources. These were a focus for the establishment of the ephemeral vegetation that occurred following the rains in the previous December (**Appendix F**), the desiccated remains of which were still present in October 2009, contributing to litter layer. A correlation appeared to exist between zones classified as 'litter patches' and the age of rehabilitation. Approximately 14% of EFA24 (2001 rehabilitation), was classified as thus, whereas only 4% of EFA22 (2004 rehabilitation) and even less for the other transects was recorded. This suggested a greater vegetative response at the older rehabilitation, onto which plants had colonised from adjacent areas.

At EFA21 (2004 rehabilitation), *Tribulus* spp. (caltrop) litter was also accumulating resources against its prostrate, spreading branches. This function was integral to the continued development of this rehabilitation, because many of the bank and trough structures had begun to flatten, with a higher proportion of many transects being classified as 'flats'. In the absence of vegetative cover, this could result in future reductions for the infiltration and nutrient cycling indices.

The older rehabilitation at EFA24 (2001) possessed well developed crabhole structures and deep cracks were beginning to form through the soft, dispersive sub-surface material. The mounded formation of EFA24 (2001 rehabilitation) meant that during rainfall, much of the water resources drain off into soaks on the extremities of

the transect. This, structure, however, very much reflects the pattern occurring in surrounding natural communities, with plant growth concentrating in lower-lying areas. At some transects such as EFA20 (2004 rehabilitation), the topsoil was eroding beneath the surface crusts, sometimes collapsing into shallow caverns and cracks, forming crabholes, which could play an important future function trapping resources. EFA08 (2006 rehabilitation) was one of the most-sloping transects, and some rills were forming at the base of the transect, originating from past tyre track disturbance.

3.7.3 Vegetation Dynamics

The cover and density values improved for all three ages of rehabilitation (**Figure 15**). The average cover value of 2004 rehabilitation exceeded the analogue averages, and the plant density for 2001 rehabilitation greatly exceeded its corresponding analogue score. A vegetation assessment was conducted at EFA08 (2006 rehabilitation) for the first time, where cover was low (0.65%), but the assessment exceeded that of like-aged EFA10. Both EFA08 and EFA10 (2006 rehabilitation) were dominated by *Sclerolaena* species, with very few grasses in their assemblage, leading to some of the lowest density values of any Beverley site. The cover value of EFA23, however, which also represented 2006 rehabilitation had increased 15 times from 0.12% to 1.8%, though was dominated by short-lived *Tribulus* spp. and *Dactyloctenium radulans* (button grass). It was one of the few transects, though, to also support the perennial grass *Astrebla pectinata* (barley Mitchell grass), albeit in a dormant state.

Cover values increased at all three transects for the 2004 rehabilitation. The largest increase was at EFA22 where it increased from less than 1% to over 4%, due to ephemeral growth following the previous December's rain. At EFA24 (2001 rehabilitation) there was smaller cover increase, because the short-lived species that had recruited at other transects were largely absent. The survival rate of the *Sclerolaena* individuals that had recruited here, however, was expected to be longer than the *D. radulans* and *Tribulus* spp. which dominated 2004 and 2006 rehabilitation.

Each age of rehabilitation retained a comparable number of species along their respective transects (**Table 8**). Much of the rehabilitation was dominated by coloniser species such as *Salsola tragus* (roly poly), *Dissocarpus paradoxus* (cannonball) and *Tribulus* spp. The later, while often desiccated and approaching senescence, contributed greatly to cover values due to its prostrate and sprawling habit. *A. pectinata* was not a dominant species at any of the rehabilitation, and usually only occurred on the drill-pad edges. A small amount of the perennial grass, *Eragrostis eriopoda* (woollybutt), occurred at EFA10.

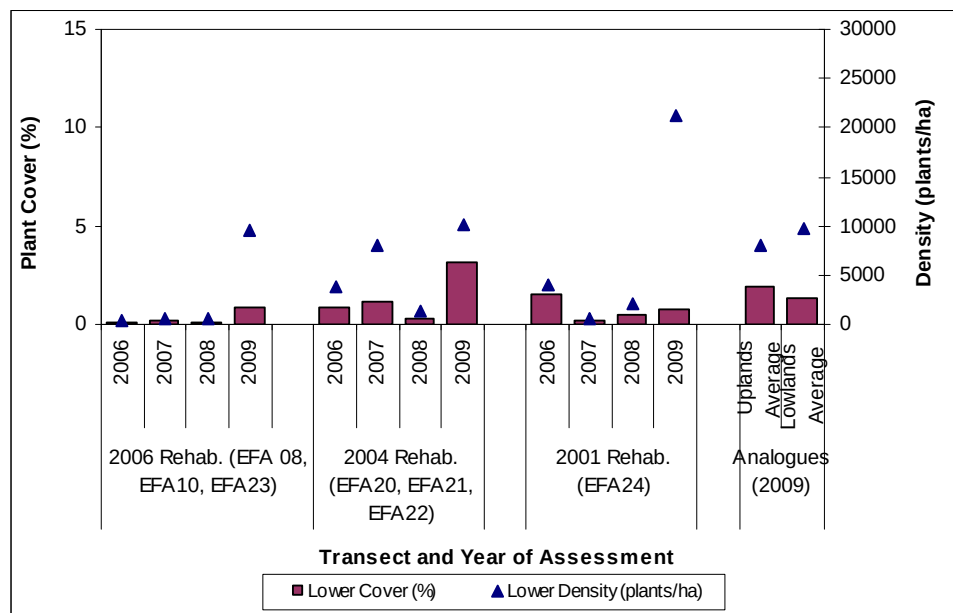


Figure 15: Changes in the plant cover index and density of the rehabilitated Mitchell grass plains drill pads

Table 8: Number of species present at rehabilitated Mitchell grass plain drill pads

Year of Assessment	2006	2007	2008	2009
2001 Rehabilitation	5	4	4	4
2004 Rehabilitation	6	4	5	6
2006 Rehabilitation	2	5	5	6
Average Uplands Analogue	5	7	7	8
Average Lowlands Analogue	6	7	8	8

3.7.4 Habitat Complexity

Habitat complexity values remained relatively low, due to the lack of faunal niches provided by plant cover, but comparable to the upland and lowland plains analogues (**Appendix E**). Evidence of kangaroo activity (scats) was present at most transects, including camps at EFA22 and EFA20 (2004 rehabilitation). Invertebrate activity was present at EFA21 (2004 rehabilitation) in the form of spider holes. Scratchings and scats of small fauna were also identified at EFA21 and EFA22 (2004 rehabilitation). In addition, rabbit scats were identified at EFA23 (2006 rehabilitation) and possible dog droppings at EFA21 (2004 rehabilitation).

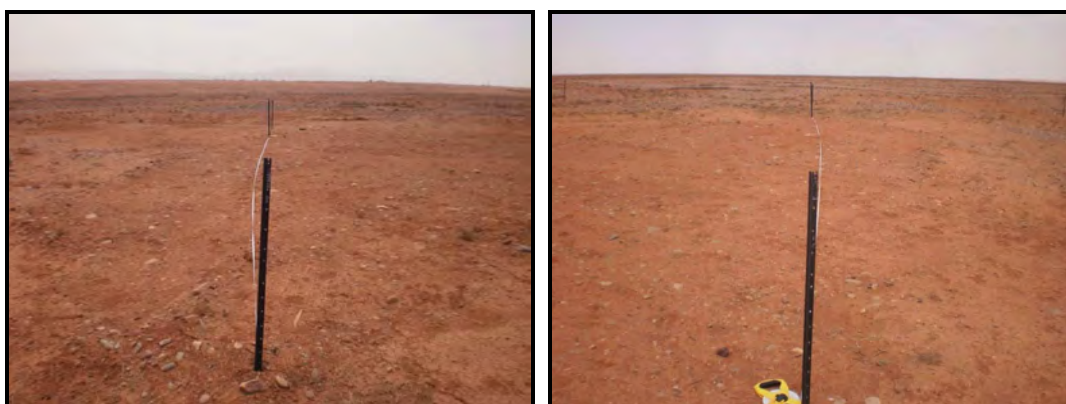
3.7.5 Plates



Plates 33 & 34: EFA08 (2006 rehabilitation) in 2009 at 0 m (left) and end marker (right) is the most sloped of rehabilitated drill pads.



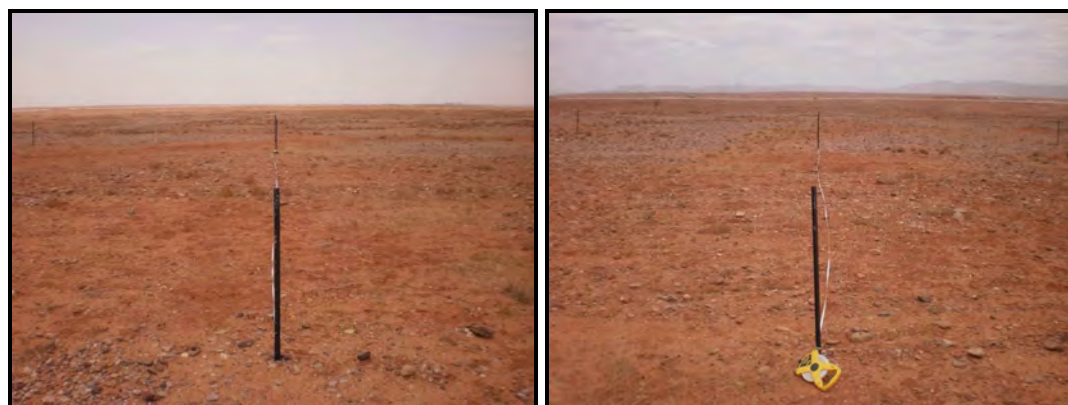
Plates 35 & 36: EFA10 (2006 rehabilitation) in 2009 at 0 m (left) and end marker (right) comprises mostly of bare un-crusts ground.



Plates 37 & 38: EFA23 (2006 rehabilitation) in 2009 at 0 m (left) and end marker (right) has undergone litter vegetation establishment.



Plates 39 & 40: EFA20 (2004 rehabilitation) in 2009 at 0 m (left) and end marker (right), with disturbance caused by foot-traffic clearly evident in the right-hand-side photo.



Plates 41 & 42: EFA21 (2004 rehabilitation) in 2009 at 0 m (left) and end marker (right) with ripped structure almost entirely flattened, but still evident in right-hand-side photograph.



Plates 43 & 44: EFA22 (2004 rehabilitation) in 2009 at 0 m (left) and end marker (right) is prone to surface disturbance. Vehicle tracks can be seen in the left-hand-side photograph.



Plates 45 & 46: EFA24 (2001 rehabilitation) in 2009 at 0 m (left) and end marker (right) showing cracking soils and forming crabhole in the foreground of the left-hand-side photograph.

3.8 Rehabilitated Drill Pads – Northern Creeklet

3.8.1 Site Description

Three transects (EFA16 and EFA18) (**Plates 47-50**) were established on rehabilitated drill pads on the edge of the Northern Creeklet. All drill pads were rehabilitated in 2005, which involved re-profiling the contour of the drill pad to blend in with surrounding Northern Creeklet floodplain landscape and ripping the upper surface. Transects have been compared with the averages for the Mitchell grass lowland plains and the drainage line analogues.

3.8.2 Landscape Function

The landscape function indices remained relatively comparable between assessments (**Figure 16**), though an increase in the infiltration index was noted, which in 2009 surpassed that of the analogues. This was due to a higher score being assigned to soil surface roughness, which is a measure of the depth of potential resource sinks (such as troughs). The surface nature had also softened somewhat, with the resistance to disturbance scores decreasing between assessments. A few crabholes were beginning to develop and despite the formation of a thin surface crust, the surface was generally loose and easily disturbed.

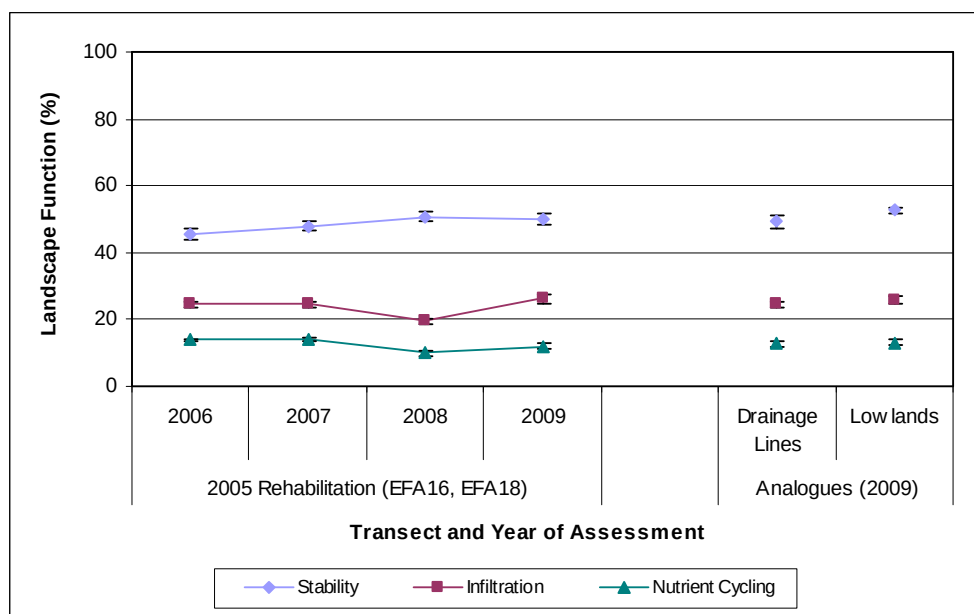


Figure 16: Changes in landscape function of the rehabilitated northern creeklet drill pads

3.8.3 Vegetation Dynamics

The average plant cover and density values were slightly higher though relatively unchanged since the 2008 assessment (**Figure 17**). This occurred due to the increase in biomass following the December rain event. Cover was recorded at EFA18 for the first time in 2009, having been colonised by species including the perennial grass *Astrela pectinata* (barley Mitchell grass). The cover value for EFA16 increased from 3% to 7%, which made the average higher than that of the lowland analogues, though it remained well below that of the drainage line analogues. The density value was below both analogue groups. The values determined for

the drainage line analogues were considered largely unachievable due to the difference in the morphological geography of site placement, with neither of the rehabilitated transects occurring directly in the drainage channel. Of the analogues, EFA15 most closely resembled the rehabilitation due to its position further up the creek bank.

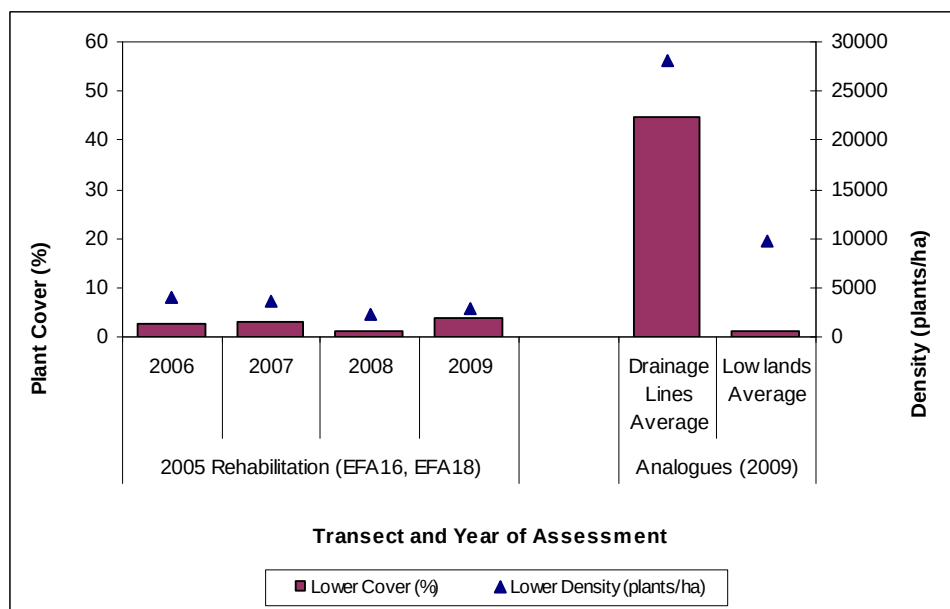


Figure 17: Changes in the plant cover index and density of the rehabilitated northern creeklet drill pads

The number of species present was comparable to previous years of assessment (**Table 9**). This included the perennial woody shrub *Maireana aphylla* (cottonbush), with EFA16 being the only rehabilitated transect to support this species, and the perennial grass *A. pectinata*. Other grasses present included *Aristida contorta* (kerosene grass) and *Sporobolus actinocladius* (katoora). The dried remains of *Cucumis* sp. (paddy melon) were also present in the drainage line adjacent to these transects.

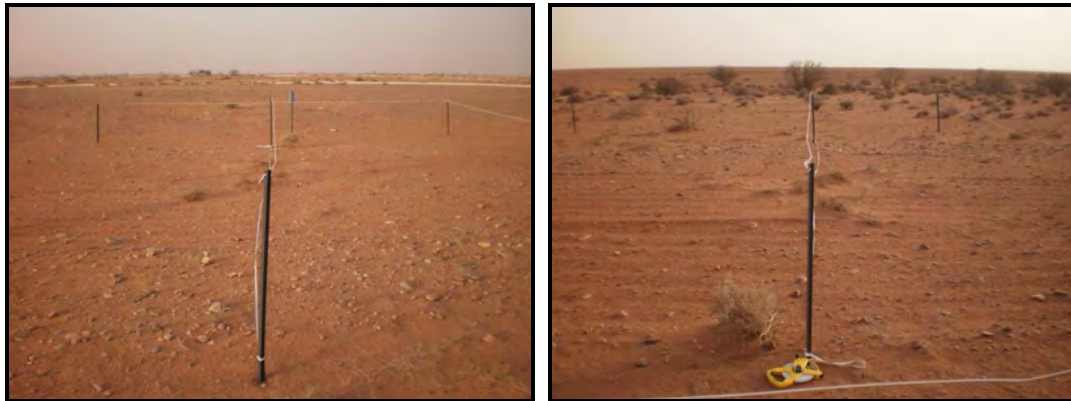
Table 9: Number of species present at rehabilitated northern creeklet drill pads

Year of Assessment	2006	2007	2008	2009
2005 Rehabilitation	5	5	5	5
Average Creek and Drainage Line Analogue	8	9	8	9
Average Lowlands Analogue	6	7	8	8

3.8.4 Habitat Complexity

The habitat complexity remained more comparable to the lowland analogues than those of the creeks and drainage lines. This was largely due to the continued lack of vegetative layers, providing fewer habitat niches than the shrubs and small trees of the drainage lines (**Appendix E**). Invertebrate activity was present in the form of spider holes at EFA18. Kangaroos tracks and scats were evident at both transects.

3.8.5 Plates



Plates 47 & 48: EFA16 in 2009 at 0 m (left) and end marker (right), showing sediment accumulating against vegetative barriers.



Plates 49 & 50: EFA18 in 2009 at 0 m (left) and end marker (right), with the rip lines still evident across the surface.

3.9 Rehabilitated Drill Pads – Four Mile Floodplain

3.9.1 Site Description

Two transects were established on rehabilitated drill pads within the Four Mile Creek floodplain, approximately 1.1 km north-east of the Beverley processing plant (**Plates 51-54**). Transect EFA13 was on 2004 rehabilitation and transect EFA14 on 2006 rehabilitation. Rehabilitation methods at both sites involved the backfilling of drill pits, replacing stockpiled topsoil and re-profiling the upper surface of the pad to blend in with the surrounding flood plain landscape. The progress of rehabilitation on these drill pads has been compared to the Four Mile Creek flood plain analogue (EFA12) that is 200 m to the north, and the Mitchell Grass Lowland analogues.

3.9.2 Landscape Function

The landscape function indices remained comparable between assessments (**Figure 18**), but for both transects remained below the analogue averages. The surface crusts remained very thin and fragile, though maintained the integrity they had achieved at the time of the 2008 assessment. Despite this, EFA14 (2006 rehabilitation) retained the lowest stability index of all Beverley transects. Patchy cryptogam cover was noted, however, in the vicinity of both transects.

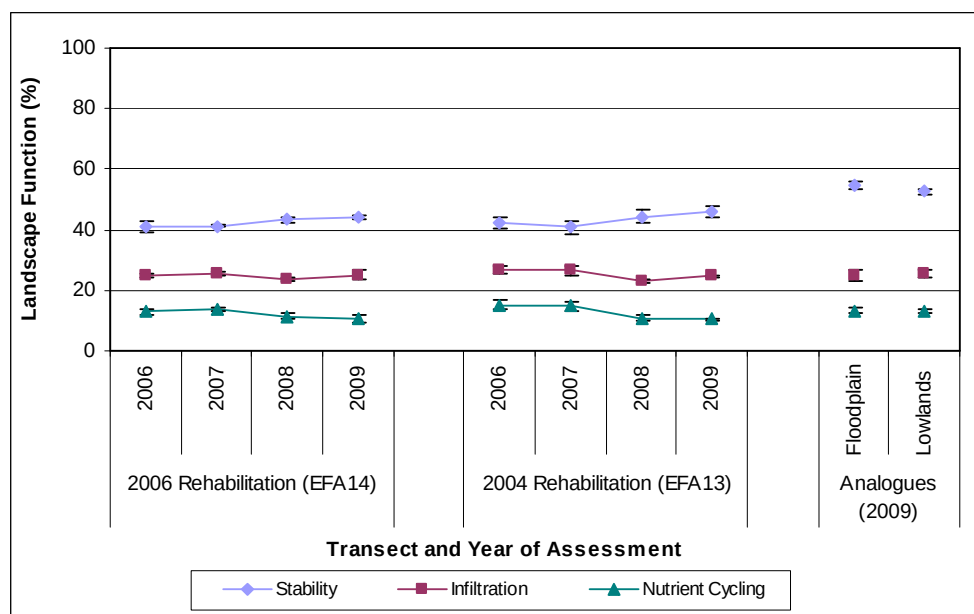


Figure 18: Changes in landscape function of the rehabilitated Four Mile floodplain drill pads

These transects recorded less of an ephemeral response to the December rains. The proportion of litter patches recorded along the transects improved but this had not translated into a marked increase in the infiltration or nutrient cycling indices, which for the later remained some of the lowest of all Beverley transects.

Crabholes were common features, reflecting the softer floodplain sediment present, and were forming where water had drained off the domed rehabilitation structures, particularly at EFA14. Some erosion of underlying material was occurring, where crusts had been disturbed, forming deep cracks through the highly dispersive

material. At EFA13, pedestalling and micro-terracing of the surface crusts was occurring at crack edges. Fine wind-blown material had also accumulated against those obstacles present such as shrub bases.

3.9.3 Vegetation Dynamics

The vegetation cover and density had improved for both ages of rehabilitation since the 2008 assessment (**Figure 19**) and both values exceeded those of the analogue averages. At EFA14, the cover value improved from 1% to over 7%. At both transects, the average distance to the nearest plant more than halved due to the recruitment of short-lived species following the previous December's rain (**Appendix F**), the desiccated remains of which contributed to litter levels. Unlike many of the other transects, this comprised mostly of *Sclerolaena* species (**Appendix D**), with very few grasses present at either transect. There was considerable seed matter incorporated with the surface material, indicating that seed had set and that the large seed resource could result in an improved, if temporary, response to future rainfall events. Transect EFA14 had a greater contribution from short-lived grasses, hence its higher cover value, including the annual *Dactyloctenium radulans* (button grass), which accounted for much of the increase observed at this transect.

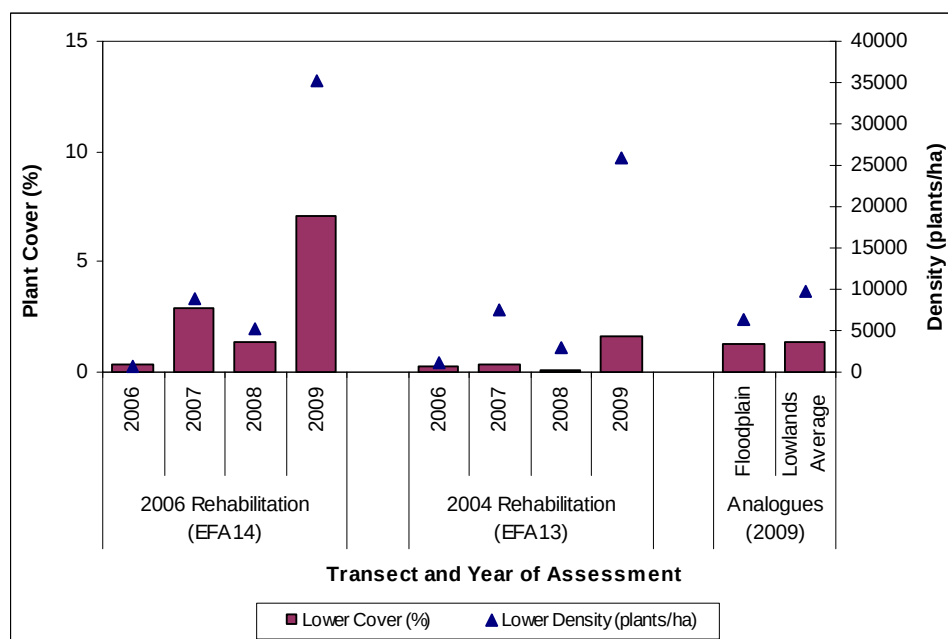


Figure 19: Changes in the plant cover index and density of the rehabilitated Four Mile floodplain drill pads

The number of species present remained comparable to previous assessments, but was half that of the analogue transects (**Table 10**), mostly through the absence of grasses such as *Astrebla pectinata* (barley Mitchell grass) which was very sparse and only present where it had colonised the rehabilitation edges.

Table 10: Number of species present at rehabilitated floodplain drill pads

Year of Assessment	2006	2007	2008	2009
2004 Rehabilitation	5	5	4	4
2006 Rehabilitation	3	4	3	4
Flood Plains Analogue	4	7	9	8
Average Lowlands Analogue	6	7	8	8

3.9.4 Habitat Complexity

The habitat complexity of the rehabilitation remained low due to the absence of significant vegetative storeys or faunal niches (**Appendix E**). There were a number of diggings and burrows that could indicate the presence of small-mammal species. Invertebrates were also present, with spider holes and antlion traps recorded, though neither occupants were actually observed. It was evident that kangaroos also utilised the area with camp areas in both rehabilitated transects where the surface had been disturbed. The surface crusts here were extensively broken by kangaroo activity.

3.9.5 Plates



Plates 51 & 52 EFA13 in 2009 at 0 m (left) and end marker (right), showing where a kangaroo has camped in the foreground of the right-hand-side photograph.



Plates 53 & 54 EFA14 in 2009 at 0 m (left) and end marker (right), has an easily disturbed surface crust.

4. CONCLUSIONS AND RECOMMENDATIONS

The soft, puffy soils characteristic of the land systems present were generally prone to disturbance and when the surface crust is broken, they are generally slow to recover. The vegetation component was ephemeral and short-lived, rapidly regenerating from seed or dormant butts following rain, setting seed and drying or becoming senescent within a short period. The remains therefore contribute to litter layers which either function as a trap for wind-blown resources or are broken down and incorporated into the soil, providing additional elements of stability to the surface.

The analogues representing the upland and lowland plains fit this model closely. They are characterised by fragile surface crusts and low cover of perennial vegetation (under 5%). The most widespread long-term perennial species was *Astrebla pectinata* (barley Mitchell grass). Growth was confined to areas where resources had accumulated, particularly the depressions and crabholes, caused by dispersion of the fine clay sub-soil and collapse or slump of the upper profile. This often exposed soft, underlying material and such features often undergo natural expansion over many years due to their unstable edges, and are often crumbly or fragile in nature.

A number of treatments had been applied to rehabilitated surfaces including the contour ripping and the blending of drill pads to match surrounding topography. The proportion of resource-capture zones was often higher on those with a ripped structure, but as these banks and troughs flatten, through the weathering process, the capacity for them to capture extant material is reduced, particularly in the absence of vegetative contribution. Many of the rehabilitated drill pads possessed an engineered dome structure that allows water to run-off onto the surrounding area following heavy rainfall. For older rehabilitation this had allowed the formation of some deep cracks, rills and depressions that could become crabholes.

The patchiness of the surrounding landscape was often comparable to the rehabilitated areas, but because many of the transects only sampled a length of 10-15 metres, they did not often capture the variety of individual components present. The Airlift Pit and Clay Batching Pad landforms, while 50 m long, comprised of consistent bank/trough formations that were yet to resemble the surrounding communities.

The landscape function indices generally remained comparable to those achieved during the 2008 assessment, and for most transects, remained within several percent of their 2006 and 2007 scores, exemplifying the slow rate of change in this low-rainfall environment. In many cases, they closely resembled or exceeded the analogue levels due to the similarly low performance of the target landscape. The analogues that did not bear resemblance to any of the rehabilitation were those located in drainage lines. These generally supported higher levels of woody shrub cover and therefore better litter and resource traps. They also had a coarser (but less crusted) topsoil and were more prone to erosion. The most comparable rehabilitation to these areas located adjacent the northern creeklet, but even this more closely resembled the lowland plains or floodplain analogues.

The most notable difference between the various ages of rehabilitation was the better formation of physical and organic soil crusts on older sites. While remaining very fragile and easily broken (as at the analogue transects),

these crusts provided better surface protection against erosion and provided a firmer, less mobile substrate for plant development. As such, the stability index was often higher for older rehabilitation, but rarely did it exceed the analogue value. The integration of stony material in the upper profile and on the surface also influenced the stability index, by providing protection against rainsplash protection and reducing the mobilisation of finer sediments or formation of erosion features.

The vegetation assemblage was dominated by short-lived and opportunistic *Sclerolaena* (copperburr) species. Their dominance was closely linked to the availability of water. The values for cover and density are therefore prone to fluctuate with seasonal conditions. A comparison with the analogues for the same year of assessment is therefore a more useful gauge of rehabilitation success than the results for a single rehabilitated landform over time.

The rainfall event received in December 2008 (over 70 mm) was the highest since monitoring began in 2006. It promoted an unprecedented ephemeral flush, dominated by summer-rainfall species such as the annual grass *Dactyloctenium radulans* (button grass), the abundant seed of which had since blown and accumulated against remaining obstacles. It also promoted the re-sprout of the dormant butts and tussocks of perennial grasses, such as *A. pectinata* and *Eragrostis eriopoda* (woollybutt), which before the rain had been lacking any photosynthetic material, and little above-ground biomass.

The proportion and quality of 'patch' or resource-accumulating zones increased between assessments following the provision of litter from the preceding year's rainfall. Given that they still occupied only a small proportion of the transects (less than 10% in most cases) this translated to only negligible change for the infiltration and nutrient cycling indices, which are closely aligned to plant and litter cover.

The rain also triggered a response of species such as *Salsola tragus* (roly poly) and *Tribulus* spp. (caltrop), which as effective colonisers of disturbed areas, readily established on Beverley rehabilitation. They were providing an important stabilising and successional function given that the landforms and rehabilitated drill pads were not originally seeded. Given the low (and variable) average rainfall, it is unlikely populations of these species will reach unsustainable levels where they begin to outcompete higher-order species, as is known to occur in higher rainfall areas.

No introduced species were identified immediately adjacent to the analogue or rehabilitation transects. The *S. tragus* and *Tribulus terrestris* occur globally, and though originally introduced to Australia, they are both now considered naturalised in Australia. In some parts of Australia, such as in the South Australian rangelands, the introduced mallow *Malvastrum americanum* (malvastrum) is also considered naturalised and not recognised among Beverley's other alien species. It was present near some analogues and rehabilitation. The rains of the previous December did however cause the recruitment of *Cucumis* spp. (paddy melon) individuals in areas where it had not previously been recorded, including near some of the creekline transects. Following the intervening dry period, many of these individuals had not become properly established and had since undergone mortality.

The intended method of plant establishment is for gradual encroachment onto the rehabilitated surface from the surrounding natural plain communities. As such, much of the establishing cover occurred on the very edges of the rehabilitation zone. A number of the colonising, annual species were included in the 2009 plant assessment, as residual biomass from the December 2008 rainfall event, and thus cover and density values were the highest recorded in the four years of monitoring and often exceeded the analogue transects.

Only one transect possessed a vegetative storey that exceeded the 3 m prescribed for an independent overstorey assessment. Running parallel to the creekline, it comprised mostly of *Acacia tetragonophylla* (dead finish) individuals. The sparseness of 3 m individuals, however, meant that the assessment extended beyond the study zone immediately adjacent the transect, and represents a 350 m stretch of the creekline community. Consideration could be given to altering the overstorey assessment method during future assessments to better capture condition along the actual transect, such as reducing the height threshold to 2m or using a quadrat-based method to determine percentage cover. It is unlikely that any of the presently monitored rehabilitation will achieve such an overstorey, due to none of the rehabilitated transects being located in such creeklines.

The calcrete borrow-pit, located 25km south of the operating plant, was different from all other rehabilitation. It was located on a slope and comprises of hard calcrete material. This transect does not have an analogue transect with which to compare its results against, and consideration could be given during future assessments to install a representative site in the surrounding area. In 2008, analogue transects were installed in the Four Mile and Beverley East (Zone 3) expansion zones, to be used for comparative purposes once rehabilitation has been complete in adjacent areas.

Habitat complexity was generally very low given the absence of multiple vegetative storeys or abundant faunal niches. The exception was for the creekline analogues, which possessed better developed mid-shrub and upper storey layers. Invertebrates had begun to colonise some of the rehabilitated landforms and drill-pads, most frequently expressed in the form of spider burrows. The cracking clays and deep rills of some areas also appeared to be favoured by small terrestrial fauna including mammals and reptiles with burrows, scratching and dung evident at both analogue and rehabilitated areas. Evidence of kangaroos were identified at every transect (in the form of scats and tracks). Their tracks are very obvious in the easily broken soil, and in some places such as on the Four Mile Floodplain, kangaroo activity including camps was compromising the stability of nearby transects.

Overall, the rehabilitated transects were beginning to resemble the surrounding landscape, though more through the expression of the monitored indices than their physical appearance. The success of the rehabilitation is closely allied with rainfall and, as for the analogues, their condition is expected to fluctuate on both short and long temporal scales based on seasonal and climatic variation. Therefore, the rehabilitation is best compared with the analogues of the year-of-assessment, rather than itself over successive years, because a reduction in their indices over time does not necessarily translate to an unsustainable or worse-functioning landscape. Outback Ecology has been commissioned to provide recommendations for the use of EFA in

determining completion criteria (to assess the success of rehabilitation). This will be reported on separately and will discuss this matter in greater detail, and provide advice to set interim completion criteria for the site.

Given the short length of many of the rehabilitated transects, sampling additional transects over future assessments could improve the accuracy and reliability of the results. Designing a method that specifically captures resource catching zones, such as crabholes and depressions over a larger area than that traversed by the current suite of transects, could also be considered and introduced to improve the sampling of these features, which is where most ecosystem development occurs.

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Appendix A

EFA Methods

1.0 Ecosystem Function Analysis

1.1 Background

Landscape Function Analysis (LFA) was developed by CSIRO and provides a field monitoring method that has been successfully adapted from rangeland ecosystems to suit mine site rehabilitation. The method employs indicators that assess and determine the functional status of the main landscape and ecosystem components at a rehabilitated site. The data can be used to determine whether the ecosystem on the waste landform is evolving appropriately. Poor performances may also be highlighted, and subsequent recommendations for remediation may be made.

The concept of Ecosystem Function Analysis (EFA) is based on a framework for ecosystem function that focuses on the critical processes within an ecosystem. These processes relate to the movement of vital ecosystem resources (water, nutrients, topsoil and organic matter) (Tongway *et al.*., 1997). EFA consists of landscape function analysis (LFA), together with measures of vegetation and habitat complexity. Field data (soil condition, vegetation data, habitat complexity and erosion) is collected to provide information on these processes, thereby reflecting the functionality of the ecosystem overall. Field data from the rehabilitated landforms can be compared with data from suitable analogue sites.

Analogue sites provide representative values that are typical of the landscape surrounding the mine. However, the EFA values obtained for analogue sites do not necessarily exactly reflect the capabilities of rehabilitated landforms. A rehabilitated ecosystem may be considered functional when values for landscape parameters have increased over a reasonable period of time in conjunction with other ecosystem parameters, and then reached a plateau which is in the broad range of local analogue sites. According to Tongway and Hindley (1995), plateauing of the LFA data curve at an early stage, or at low values compared to the analogue, is a warning of limited ecosystem development in rehabilitation. Such incidents cannot be determined in early monitoring, but the values attained may give some indication of future trends. Variations in vegetation data may occur from year to year, typically due to seedling recruitment, plant development, succession, grazing or climatic fluctuations. Analysis of analogue vegetation data provides an indication of these natural environmental fluctuations.

An EFA assessment is generally conducted on a transect running down a slope (i.e. waste landform batter, TSF batter, rangeland hill slopes), following the line of resource flow (Sarre, 1998). It is vital to consider resource regulation at a monitoring site, as the loss or retention of resources dictates the functioning of the landscape. Loss and retention of resources down the slope may be affected by:

- the presence or absence of obstructions (including plants);
- the nature of the soil (erodible or rocky); and
- the topography of the slope (smooth or undulating).

Resource regulation may be assessed using LFA, vegetation analysis and habitat complexity measurements.

1.2 Landscape Function Analysis (LFA)

LFA assessment is conducted along a permanent transect (up to 50m) defined by a measuring tape. All transects are essentially linear, and detailed soil assessment is conducted in sub-sections of the transect that are up to 1m long. The landscape zones on rehabilitated areas, defined as 'banks', 'troughs', and 'flats', were recorded along the transect. Variations of these landscape zones may also be recorded, such as 'plant banks', 'plant troughs' and 'plant flats'. The analogue sites close to the mine provided data for general comparison with rehabilitation data. Major landscape zones present on the analogue slopes are typically 'rocky slopes' and 'rocky flats'.

Each landscape zone has different soil surface characteristics depending on whether it collects or sheds resources (**Table 1**). A value of 1 indicates the poorest condition for each indicator assessed. Randomly-located soil surface condition assessments are conducted for all landscape zones along the transects. Soil surface condition is assessed on at least three replicates for each landscape zone.

Table 1 Indicators of soil surface condition for the landscape assessment (Tongway & Hindley, 1995).

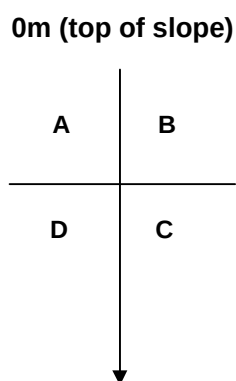
Indicator	Purpose of Measurement	Score
Soil cover	Assess susceptibility to erosion	1 - 5
Perennial basal cover	Assess the potential biomass for nutrient cycling	1 - 4
Litter cover (simple)	Assess the soil organic matter content	1 - 10
Litter cover (complex)	Assess the degree of incorporation (nutrient benefit) in soil	1 -30
Crust condition	Assess the crust stability and susceptibility to erosion	0 - 4
Erosion features	Evaluates the presence of erosion features	1 - 4
Deposited materials	The amount of deposited materials that can be remobilised	1 - 4
Cryptogam Cover	Cryptogams are a positive indicator of surface stability	0 - 4
Micro-topography	Assess the surface roughness for water and seed storage	1 - 5
Surface nature	Assess the impact that stress will have on the surface	1 - 5
Slake test	Assess the coherence of the soil when it is wet	1 - 4
Texture	Assess the proportions of different sized particles in the soil	1 - 4

1.3 Vegetation Dynamics

Key vegetation indicators were measured using the Point-Centred Quarter (PCQ) method.

Point-Centred Quarter (PCQ)

Key indicators of vegetation dynamics include plant cover (width, breadth, and height), density (plants/ha) and diversity. The PCQ method is a plotless technique that evaluates the spatial distribution of vegetation. This method is particularly useful for collecting data for sparse and randomly distributed vegetation (Tongway, 1999). Sampling points are located at 5m intervals along the transect and the sampling area is divided into quarters by mentally placing a line perpendicular to the transect.



The width, breadth, and height of species and distance from the tape of the nearest perennial plant are measured to obtain plant cover and density for each quarter. It is important to note that generally only perennial plant species are recorded, because they have a greater contribution to the productivity, stability and overall functioning of an ecosystem than annual species. However given the vegetation dynamics at the Beverley site both annual and perennial species were included in vegetation assessments.

It should be noted that in some cases, plant cover may exceed 100%. This relates to the fact that plant cover is conducted on each species independently, rather than in proportion to other species.

1.4 Habitat Complexity

The method for assessing habitat complexity has been adapted from Newsome and Catling (1979). These methods were reviewed and updated in 2003 (**Table 2**). This improvement was in response to a greater understanding of the processes of faunal colonisation in rehabilitated areas, and of key indicators of enhancements in vertebrate faunal habitat.

Table 2 Indicators of Habitat Complexity

Component	Habitat Complexity Indicators				
Vegetative Storeys	Groundcover vines, creepers, cryptograms	Under-storey grasses, herbs, 0.0 - 0.1 m	Mid-storey small shrubs, 0.5 - 1.5m	Upper-storey tall shrubs, 1.5 - 3.0 m	Overstorey > 3.0m
Available Faunal Niches	Leaf litter or perennial grasses or sticks < 5cm, or rocky scree > 2cm and < 15cm diam	Logs or rocks >25 cm diameter	Immature trees or shrubs	Mature trees or shrubs	
Ants	1 species sparse	1 species abundant	2 species sparse	2 or more species abundant	
Scats (native only)	1species sparse	1 species abundant	2 species sparse	2 or more species abundant	<i>Sources identified if possible</i>
Water Availability	Water body < 1m diam. Present or evidence	Water body > 1m diam. Present or evidence	<i>Water to be within an area 25 m either side of the transect and within 10 m top and bottom of markers</i>		

1.6 Erosion Assessment

Annual monitoring of fixed-position, erosion transects as a component of the EFA data collection process will show whether erosion on the slopes has stabilised or remains active. Erosion assessments are conducted on the upper and lower sections of the rehabilitation slopes on the waste landforms. Erosion transects are established at right angles to the main transect. The total length of the erosion transect is 50m (25m either side of the main transect). The erosion transect for the upper slope is located at 10m on the main transect and the lower slope is usually assessed at 25 or 30m, depending on the total length of the slope.

The crest of the bank immediately above the fixed positions for the upper and lower slopes is assessed. The number of rills (0.3m deep) and gullies (greater than 0.3m deep) are counted and their width and depth are measured (McDonald *et al.*., 1998).

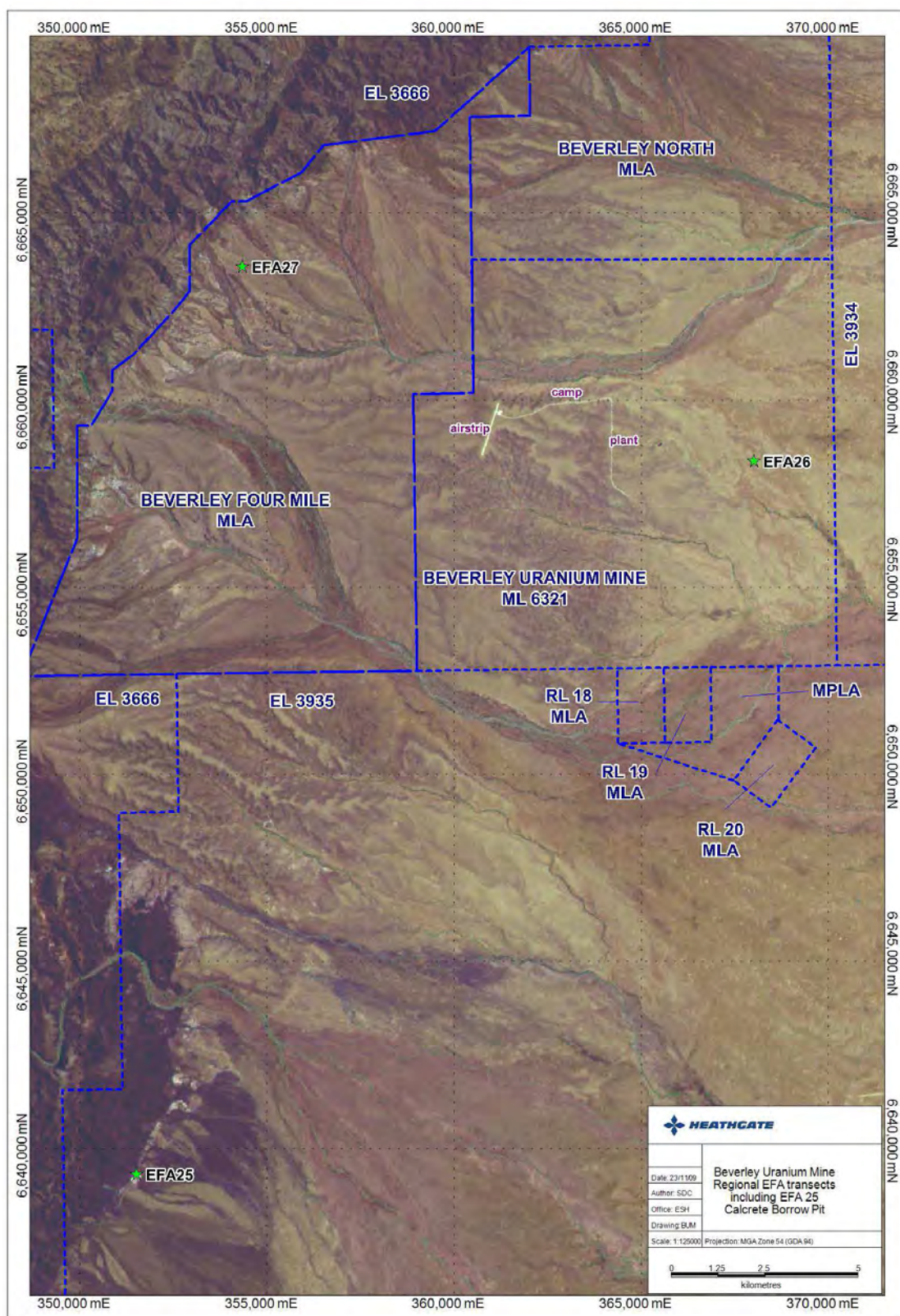
1.7 Data Analysis

Landscape data is entered into an Excel workbook developed by CSIRO which calculates the proportion of the slope covered by various landscape zones. Stability, infiltration and nutrient cycling indices for each landscape zone are calculated from the scores allocated during the soil surface condition assessment (**Table 1**). The overall stability, infiltration and nutrient cycling indices for the landscape are calculated for each landscape

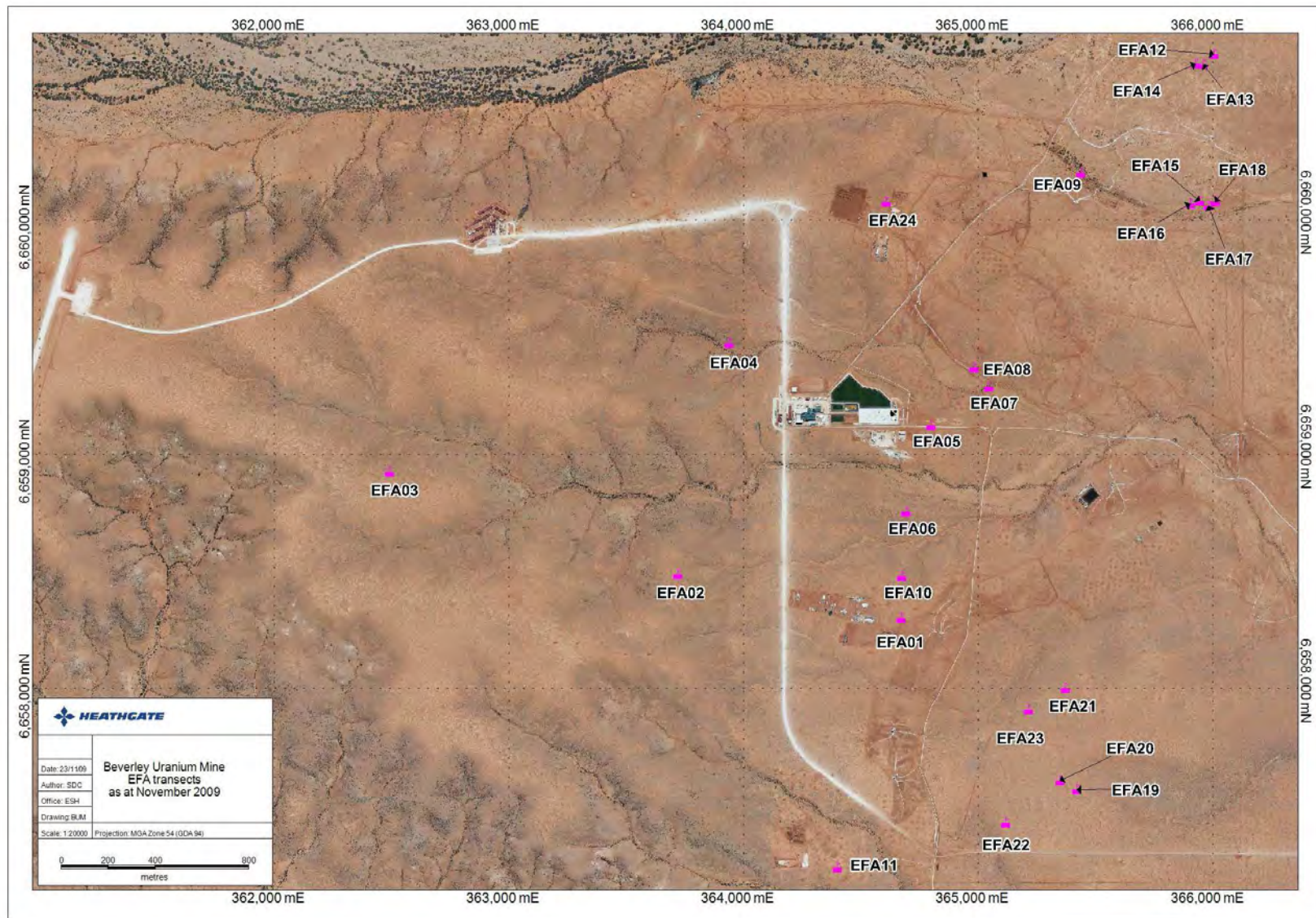
zone, and then converted to a proportion of the slope. Average stability, infiltration and nutrient cycling scores are calculated for both rehabilitation and analogue areas.

Appendix B

EFA Transect Location Maps



Appendix B(a): Map showing regional EFA transect locations



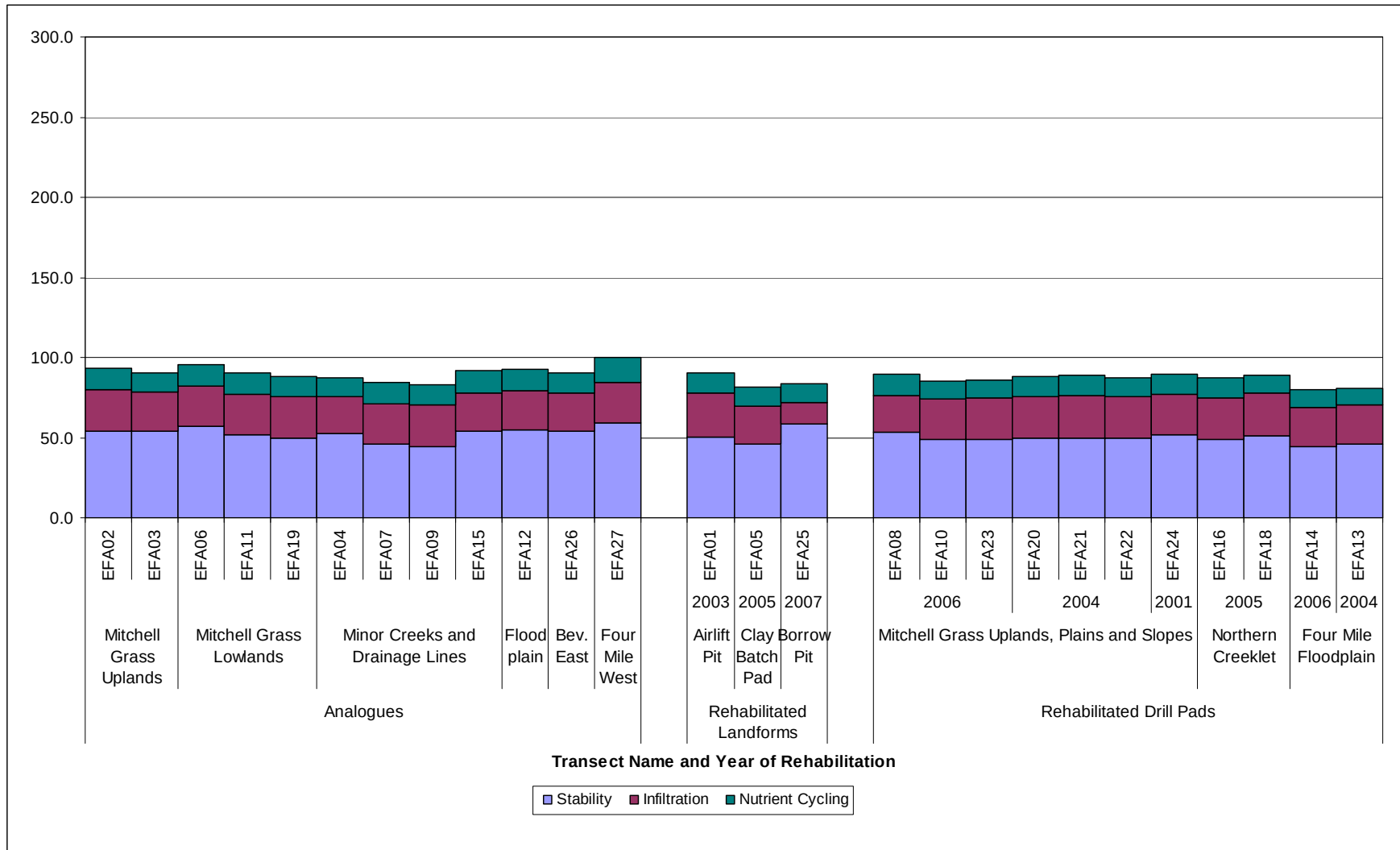
Appendix B(b): Map showing EFA transect locations

Appendix C

Raw Data, 2009

Appendix C(a): Raw Landscape Function Analysis (LFA) data (2009)

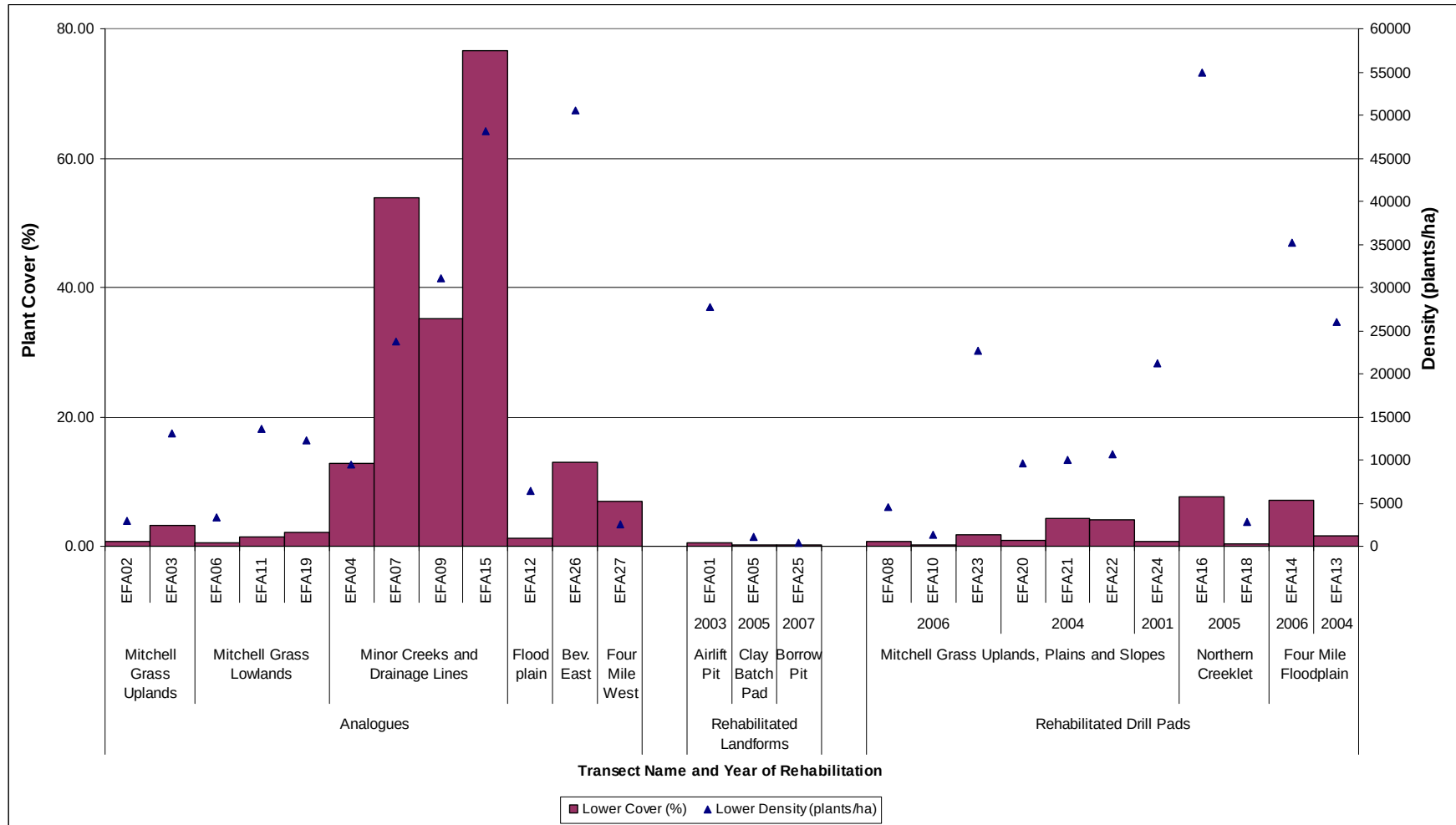
Landform		Year of rehabilitation	Transect name	Stability	Std error	Infiltration	Std error	Nutrient Cycling	Std error
Analogues	Mitchell Grass Uplands	NA	EFA02	53.8	1.3	25.9	1.1	13.5	0.7
			EFA03	54.2	0.3	24.0	1.1	12.0	0.3
	Mitchell Grass Lowlands		EFA06	56.9	0.6	25.5	2.0	13.5	0.8
			EFA11	51.5	1.7	25.5	0.9	13.1	0.9
			EFA19	49.3	0.8	26.1	0.6	12.5	0.7
			EFA04	52.7	1.0	22.6	0.7	12.1	0.3
	Minor Creeks and Drainage Lines		EFA07	45.7	1.9	25.7	0.8	13.1	0.7
			EFA09	44.4	2.8	26.2	0.9	12.4	1.2
			EFA15	54.1	2.7	23.9	0.9	13.7	1.6
	Flood plain		EFA12	54.5	1.3	25.0	1.9	13.3	0.9
Rehabilitated Landforms	Bev. East		EFA26	54.1	1.3	23.5	2.5	13.1	0.5
	Four Mile West		EFA27	59.4	2.4	24.9	1.5	15.5	1.3
	Airlift Pit	2003	EFA01	50.5	0.6	27.2	1.1	12.9	1.6
Rehabilitated Drill Pads	Clay Batch Pad	2005	EFA05	45.7	1.2	24.2	0.7	11.3	0.5
	Borrow Pit	2007	EFA25	60.3	1.0	13.9	0.5	11.9	0.3
	Mitchell Grass Uplands, Plains and Slopes	2006	EFA08	53.2	1.5	23.5	1.3	12.7	0.5
			EFA10	49.2	1.0	25.1	0.6	10.6	0.6
			EFA23	49.0	1.9	25.6	0.0	11.6	0.0
		2004	EFA20	49.6	2.4	26.0	0.3	12.2	0.4
			EFA21	49.5	0.5	26.6	0.6	12.9	0.8
			EFA22	50.0	1.2	26.1	0.2	12.3	0.3
		2001	EFA24	52.0	0.8	24.7	1.6	12.7	1.1
	Northern Creeklet	2005	EFA16	49.2	1.7	25.5	1.0	12.4	0.5
			EFA18	50.8	1.7	26.8	1.9	11.4	1.1
	Four Mile Floodplain	2006	EFA14	44.1	0.8	25.1	1.5	10.8	1.2
		2004	EFA13	46.0	1.7	24.6	0.2	10.3	0.2



Appendix C(b): Graphical representation of raw LFA data

Appendix C(c): Raw vegetation cover and density data (2009)

Landform		Year of rehabilitation	Transect Name	Lower storey plant cover (%)	Lower storey plant density (plants/ha)	Upper storey plant cover (%)	Upper storey plant density (plants/ha)
Analogues	Mitchell Grass Uplands	NA	EFA02	0.63	2922.56	None recorded	None recorded
			EFA03	3.14	13041.00	None recorded	None recorded
			EFA06	0.49	3319.40	None recorded	None recorded
	Mitchell Grass Lowlands		EFA11	1.34	13621.43	None recorded	None recorded
			EFA19	2.15	12257.97	None recorded	None recorded
			EFA04	12.86	9488.67	None recorded	None recorded
	Minor Creeks and Drainage Lines		EFA07	53.84	23734.98	None recorded	None recorded
			EFA09	35.26	31025.62	15.20	48.00
			EFA15	76.54	48185.60	None recorded	None recorded
	Flood plain		EFA12	1.25	6342.21	None recorded	None recorded
Rehabilitated Landforms	Bev. East		EFA26	12.89	50499.00	None recorded	None recorded
	Four Mile West		EFA27	6.91	2572.57	None recorded	None recorded
	Airlift Pit	2003	EFA01	0.60	27714.75	None recorded	None recorded
	Clay Batch Pad	2005	EFA05	0.16	1045.82	None recorded	None recorded
Rehabilitated Drill Pads	Borrow Pit	2007	EFA25	0.21	377.26	None recorded	None recorded
	Mitchell Grass Uplands, Plains and Slopes	2006	EFA08	0.65	4565.00	None recorded	None recorded
			EFA10	0.20	1279.00	None recorded	None recorded
			EFA23	1.82	22698.00	None recorded	None recorded
		2004	EFA20	0.87	9635.00	None recorded	None recorded
			EFA21	4.31	10013.00	None recorded	None recorded
			EFA22	4.17	10683.00	None recorded	None recorded
		2001	EFA24	0.77	21260.00	None recorded	None recorded
		2005	EFA16	7.57	54932.00	None recorded	None recorded
	Northern Creeklet		EFA18	0.38	2770.00	None recorded	None recorded
	Four Mile Floodplain	2006	EFA14	7.08	35266.00	None recorded	None recorded
		2004	EFA13	1.62	26015.00	None recorded	None recorded



Appendix C (d): Graphical representation of raw vegetation data

Appendix D

Plant Species List, 2009

Appendix D (a): Plant species recorded along analogue transects (2009)

Landform	Analogues											
	Mitchell Grass Uplands	Mitchell Grass Lowlands				Minor Creeks and Drainage Lines				Four Mile Floodplain	Beverley East (Zone 3)	Arkaroola Foothills (Four Mile West)
Year of Rehabilitation	N/A											
Transect Number	EFA02	EFA03	EFA06	EFA11	EFA19	EFA04	EFA07	EFA09	EFA15	EFA12	EFA26	EFA27
Acacia tetragonophylla												✧
Acacia sp.												✧
Astrebla pectinata	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧
Atriplex sp												
Chenopod Sp.												
Dactyloctenium radulans	✧	✧	✧		✧	✧	✧	✧		✧	✧	✧
Dissocarpus biflorus										✧		
Dissocarpus paradoxus			✧	✧	✧							
Eragrostis sp,	✧		✧	✧		✧	✧		✧		✧	
Eriochiton scleronoides										✧		
Eremophila freelingii						✧						
Eremophila sp.												✧
Grass Sp.	✧			✧		✧			✧			
Hakea leucoptera												✧
Panicum decompositum									✧			
Ptilotus obovatus						✧	✧					
Maireana aphylla								✧	✧			
Maireana sp.							✧		✧		✧	
Rhagodia spinescens								✧				
Santalum lanceolatum							✧					
Sclerolaena bicornis									✧			
Sclerolaena brachyptera	✧	✧	✧		✧					✧	✧	
Sclerolaena constricta												
Sclerolaena decurrens		✧							✧			
Sclerolaena divaricata		✧	✧			✧					✧	
Sclerolaena longicuspis	✧			✧		✧					✧	✧
Sclerolaena patenticuspis			✧									
Sclerolaena tricuspis	✧				✧					✧		
Sclerolaena ventricosa												
Sclerolaena sp.	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧	✧
Senna sp.						✧	✧					
Sida sp.					✧		✧		✧			✧
Tribulus terrestris	✧	✧	✧	✧	✧	✧		✧	✧		✧	
Tripogon lolliformis					✧					✧		

✧

✧

Denotes species that were recorded along the vegetation transect

Dominant species on the waste landform

Species Diversity

9 7 9 7 9 11 9 6 11 8 9 9

Appendix D (b): Plant species recorded along rehabilitated transects (2009)

Landform	Rehabilitated Landforms			Rehabilitated Drill Pads										
	Airlift Pit	Clay Batching Pad	Calcrete Borrow Pit	Mitchell Grass Uplands, Plains and Slopes							Northern Creeklet		Four Mile Floodplain	
				2006			2004			2001	2005		2006	2004
Year of Rehabilitation	2003	2005	2007	EFA08	EFA10	EFA23	EFA20	EFA21	EFA22	EFA24	EFA16	EFA18	EFA14	EFA13
Transect Number	EFA01	EFA05	EFA25											
<i>Acacia tetragonophylla</i>														
<i>Acacia victoreae</i>			✧											
<i>Astrelia pectinata</i>	✧			✧			✧	✧	✧	✧		✧		
<i>Atriplex</i> sp.														
<i>Chenopod</i> Sp.			✧											
<i>Dactyloctenium radulans</i>	✧	✧	✧	✧	✧	✧	✧	✧					✧	
<i>Dissocarpus biflorus</i>														
<i>Dissocarpus paradoxus</i>	✧				✧		✧	✧	✧					✧
<i>Eragrostis</i> sp.					✧			✧						
<i>Eriochiton scleronoides</i>														
<i>Eremophila freelingii</i>														
<i>Eremophila</i> sp.														
<i>Grass</i> Sp.							✧		✧		✧	✧	✧	
<i>Hakea leucoptera</i>														
<i>Ptilotus obovatus</i>														
<i>Maireana aphylla</i>											✧			
<i>Maireana</i> sp.														
<i>Panicum decompositum</i>												✧		
<i>Rhagodia spinescens</i>														
<i>Santalum lanceolatum</i>														
<i>Sclerolaena bicornis</i>		✧												
<i>Sclerolaena brachyptera</i>	✧	✧			✧	✧	✧	✧	✧	✧				✧
<i>Sclerolaena constricta</i>			✧											
<i>Sclerolaena decurrens</i>														
<i>Sclerolaena divaricata</i>					✧						✧		✧	✧
<i>Sclerolaena longicuspis</i>														
<i>Sclerolaena obliquicuspis</i>			✧											
<i>Sclerolaena patenticuspis</i>					✧									
<i>Sclerolaena tricuspis</i>														
<i>Sclerolaena ventricosa</i>														
<i>Sclerolaena</i> sp.	✧	✧		✧	✧	✧	✧	✧	✧	✧	✧		✧	✧
<i>Senna</i> sp.														
<i>Sida</i> sp.			✧		✧									
<i>Tribulus terrestris</i>	✧	✧		✧	✧	✧		✧	✧	✧	✧			
<i>Tripogon lolliformis</i>														

✧ Denotes species that were recorded along the vegetation transect

✧ Dominant species on the waste landform

Species Diversity

6 5 6 4 9 4 6 7 6 4 5 3 4 4

Appendix E

Habitat Complexity, 2009

Appendix E (a): Habitat Complexity results for analogue transects (2009)

Habitat Complexity Criteria		Mitchell Grass Uplands		Mitchell Grass Lowlands			Minor Creeks and Drainage Lines				Four Mile Floodplain	Beverley East	Four Mile West
		EFA02	EFA03	EFA06	EFA11	EFA19	EFA04	EFA07	EFA09	EFA15	EFA12	EFA26	EFA27
Vegetative Storeys	Groundcover-vines, creepers, cryptogams												
	Under-storey-grasses, herbs, 0-0.1m												
	Mid-storey-small shrubs, 0.5-1.5m												
	Upper-storey-tall shrubs, 1.5-3.0m												
	Over-storey- >3.0m												
Available Faunal Niches	Leaf litter, perennial grasses, or sticks <5cm. Rocky scree>2cm-<15cm												
	Logs, or rocks>25cm diam.												
	Immature trees, or shrubs.												
	Mature trees, or mature shrubs.												
Ants	1 species, sparse												
	1 species, abundant												
	2 or more species, sparse												
	2 or more species, abundant												
Scats	1 species, sparse												
	1 species, abundant												
	2 or more species, sparse												
	2 or more species, abundant												
Water Availability	Water body <1m diam. Present or evidence												
	Water body >1m diam. Present or evidence												

Appendix E (b): Habitat Complexity results for rehabilitated transects (2009)

Habitat Complexity Criteria		Rehabilitated Landforms			Rehabilitated Drill Pads										
		Airlift Pad	Clay Batching Pad	Calcrete Borrow Pit	Mitchell Grass Uplands, Plains and Slopes							Northern Creeklet		Four Mile Floodplain	
Transect ID		EFA01	EFA05	EFA25	EFA08	EFA10	EFA23	EFA20	EFA21	EFA22	EFA24	EFA16	EFA18	EFA14	EFA13
Vegetative Storeys	Groundcover-vines, creepers, cryptogams														
	Under-storey-grasses, herbs, 0-0.1m														
	Mid-storey-small shrubs, 0.5-1.5m														
	Upper-storey-tall shrubs, 1.5-3.0m														
	Over-storey- >3.0m														
Available Faunal Niches	Leaf litter, perennial grasses, or sticks <5cm. Rocky scree>2cm-<15cm														
	Logs, or rocks>25cm diam.														
	Immature trees, or shrubs.														
	Mature trees, or mature shrubs.														
Ants	1 species, sparse														
	1 species, abundant														
	2 or more species, sparse														
	2 or more species, abundant														
Scats	1 species, sparse														
	1 species, abundant														
	2 or more species, sparse														
	2 or more species, abundant														
Water Availability	Water body <1m diam. Present or evidence														
	Water body >1m diam. Present or evidence														

Appendix F

Transect Photographs

(Oct '08, Jan '09, Oct '09)

Analogues – Mitchell Grass Uplands

Figure 2 EFA02 (Mitchell Grass Uplands Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 3 EFA03 (Mitchell Grass Uplands Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Analogues – Mitchell Grass Lowlands

Figure 6 EFA06 (Mitchell Grass Lowlands Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 11 EFA11 (Mitchell Grass Lowlands Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 18 EFA19 (Mitchell Grass Lowlands) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Analogues – Minor Creeks and Drainage Lines



Figure 4 EFA04 (Minor Creeks and Drainage Lines Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)

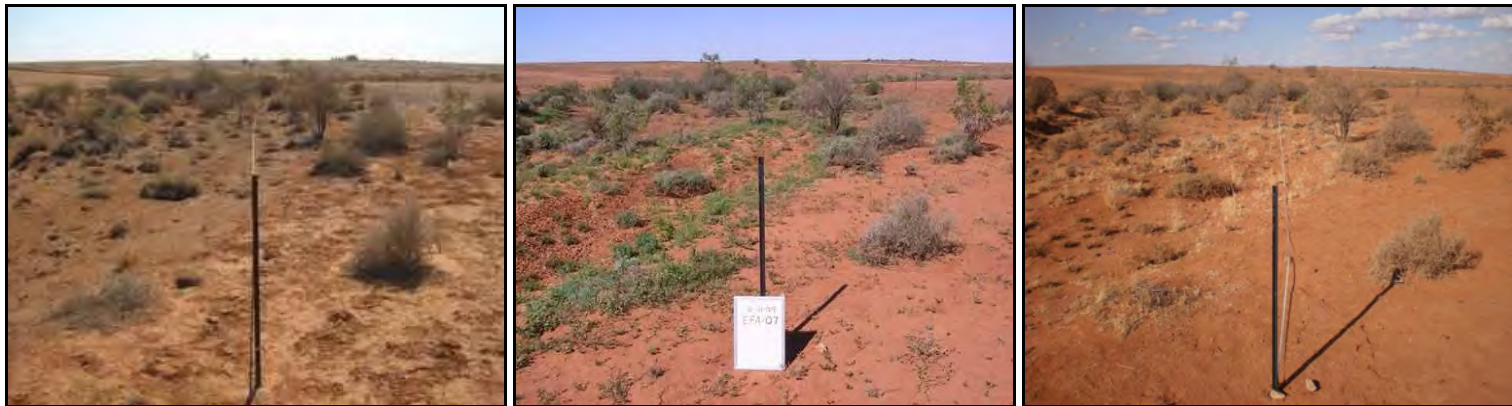


Figure 7 EFA07 (Minor Creeks and Drainage Lines Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 9 EFA09 (Minor Creeks and Drainage Lines Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 15 EFA15 (Minor Creeks and Drainage Lines Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Analogues – Four Mile Flood Plain

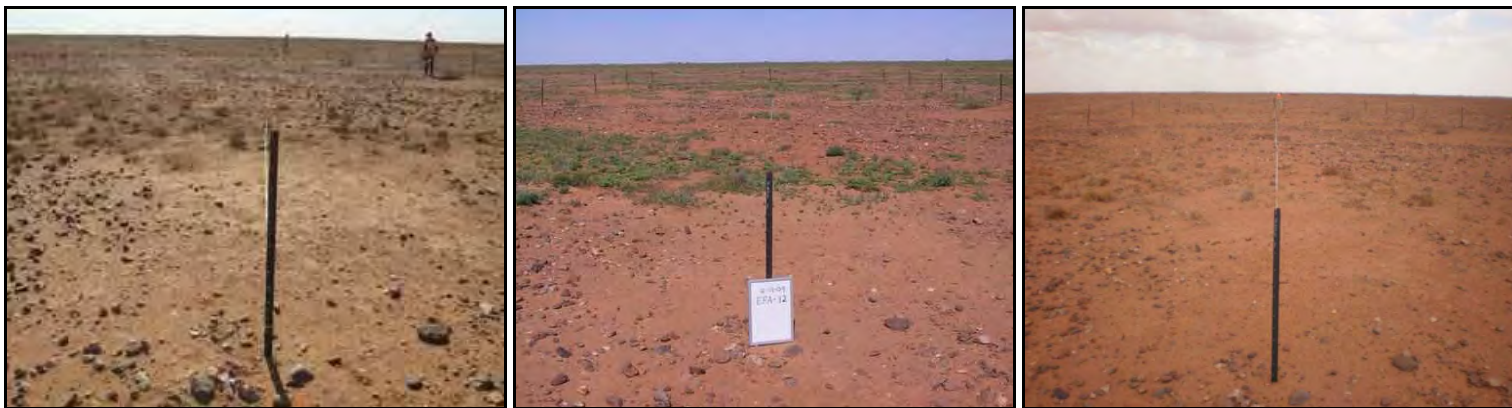


Figure 12 EFA12 (Four Mile Floodplain Analogue) in October 2008 (left), January 2009 (middle) and October 2009 (right)

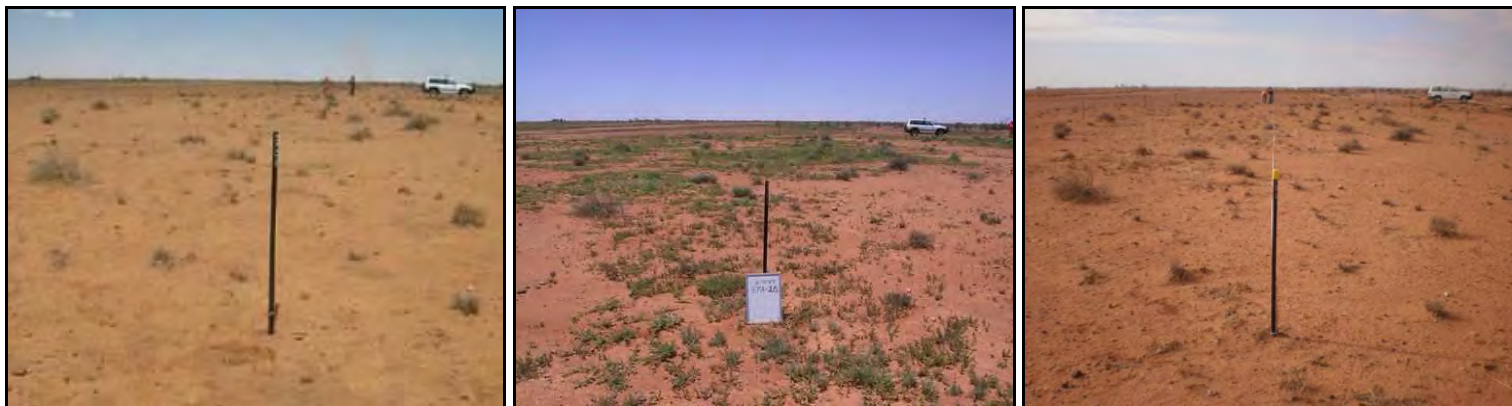
Analogues – Beverley East

Figure 25 EFA 26(Beverly East Zone 3) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Analogues – Four Mile West

Figure 26 EFA 27 (Arkaroola Foothills Four Mile West) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Rehabilitation – Airlift Pit

Figure 1 EFA 01 (Airlift Pit) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Rehabilitation – Clay Batching Pad

Figure 5 EFA05 (Clay Batch Pad) in October 2008 (left), January 2009 (middle) and October 2009 (right)

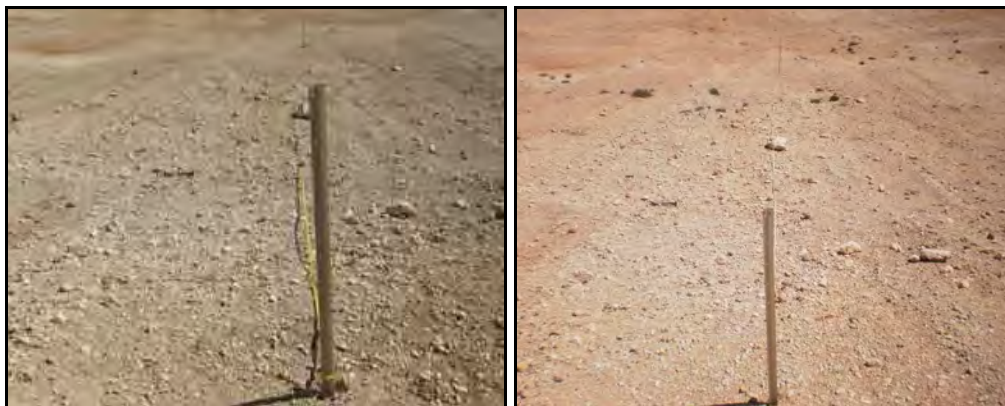
Rehabilitation – Calcrete Borrow Pit

Figure 24 EFA 25(Calcrete Borrow Pit) in October 2008 (left) and October 2009 (right) (photo unavailable for January 2009)

Rehabilitation – Drill pads on Mitchell grass plains and slopes (2006 Rehabilitation)

Figure 8 EFA 08 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 10 EFA10 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 22 EFA23 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)

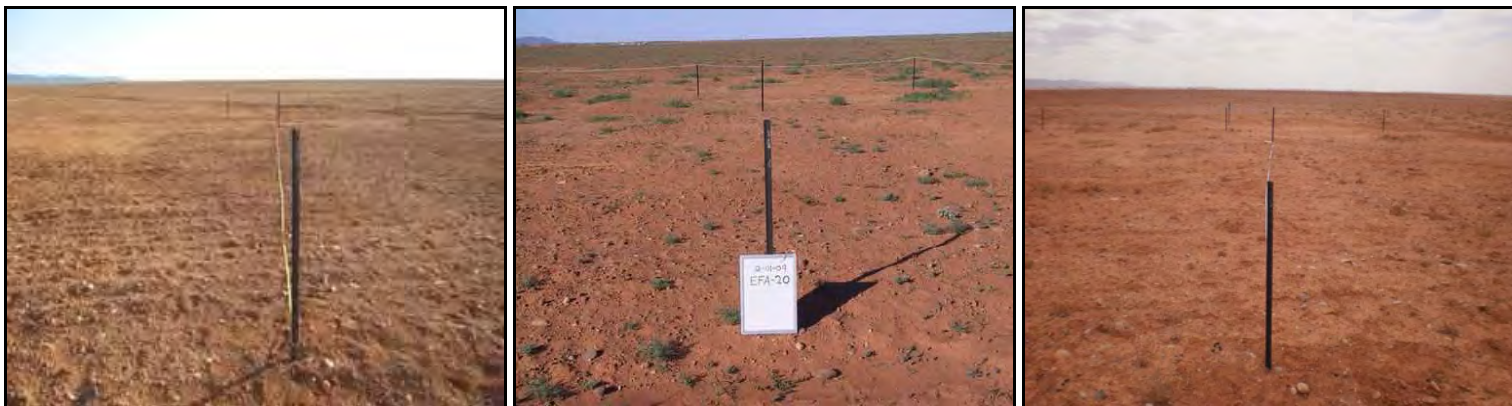
Rehabilitation – Drill pads on Mitchell grass plains and slopes (2004 Rehabilitation)

Figure 19 EFA20 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 20 EFA21 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)



Figure 21 EFA22 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Rehabilitation – Drill pads on Mitchell grass plains and slopes (2001 Rehabilitation)



Figure 23 EFA24 (Mitchell Grass Uplands, Plains and Slopes) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Rehabilitation – Drill pads on Northern Creeklet (2005 Rehabilitation)

Figure 16 EFA16 (Northern Creeklet) in October 2008 (left), January 2009 (middle) and October 2009 (right)

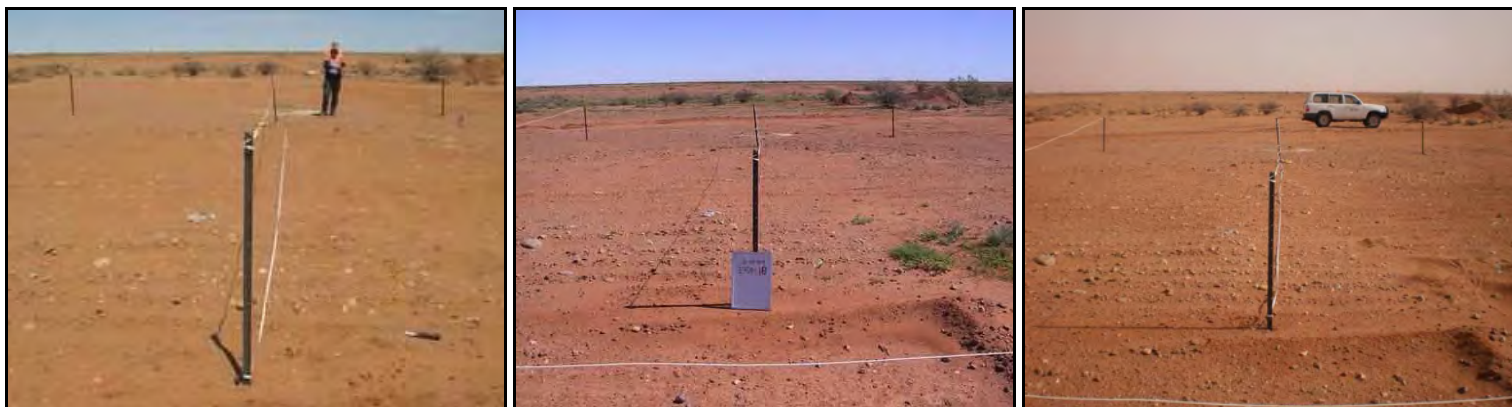


Figure 17 EFA18 (Northern Creeklet) in October 2008 (left), January 2009 (middle) and October 2009 (right)

Rehabilitation – Drill pads on Four Mile Creek floodplain (2006 Rehabilitation)

Figure 14 EFA14 (Four Mile Creek Floodplain) in October 2008 (left), January 2009 (middle) and October 2009 (right)

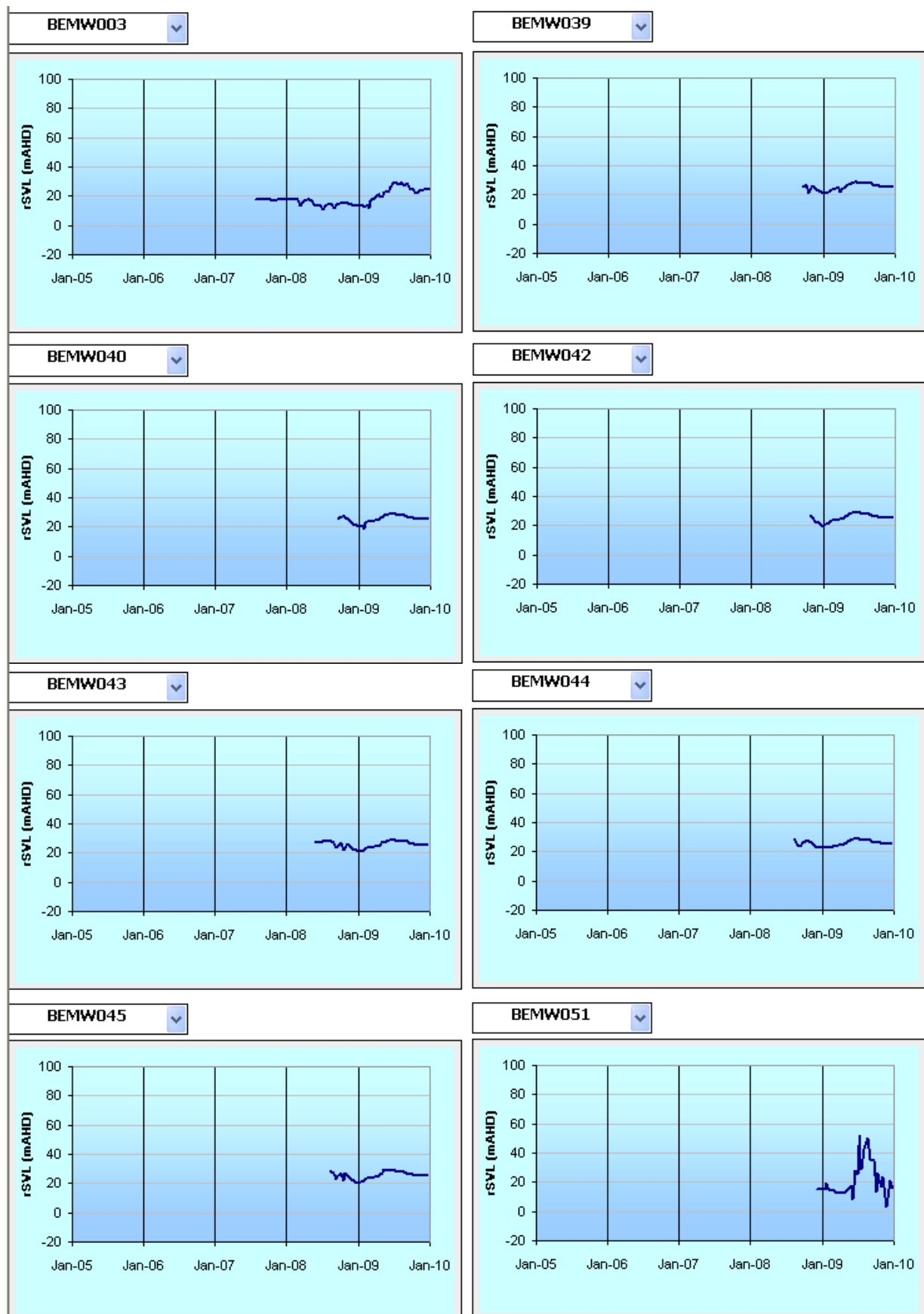
Rehabilitation – Drill pads on Four Mile Creek floodplain (2004 Rehabilitation)

Figure 13 EFA13 (Four Mile Creek Floodplain) in October 2008 (left), January 2009 (middle) and October 2009 (right)

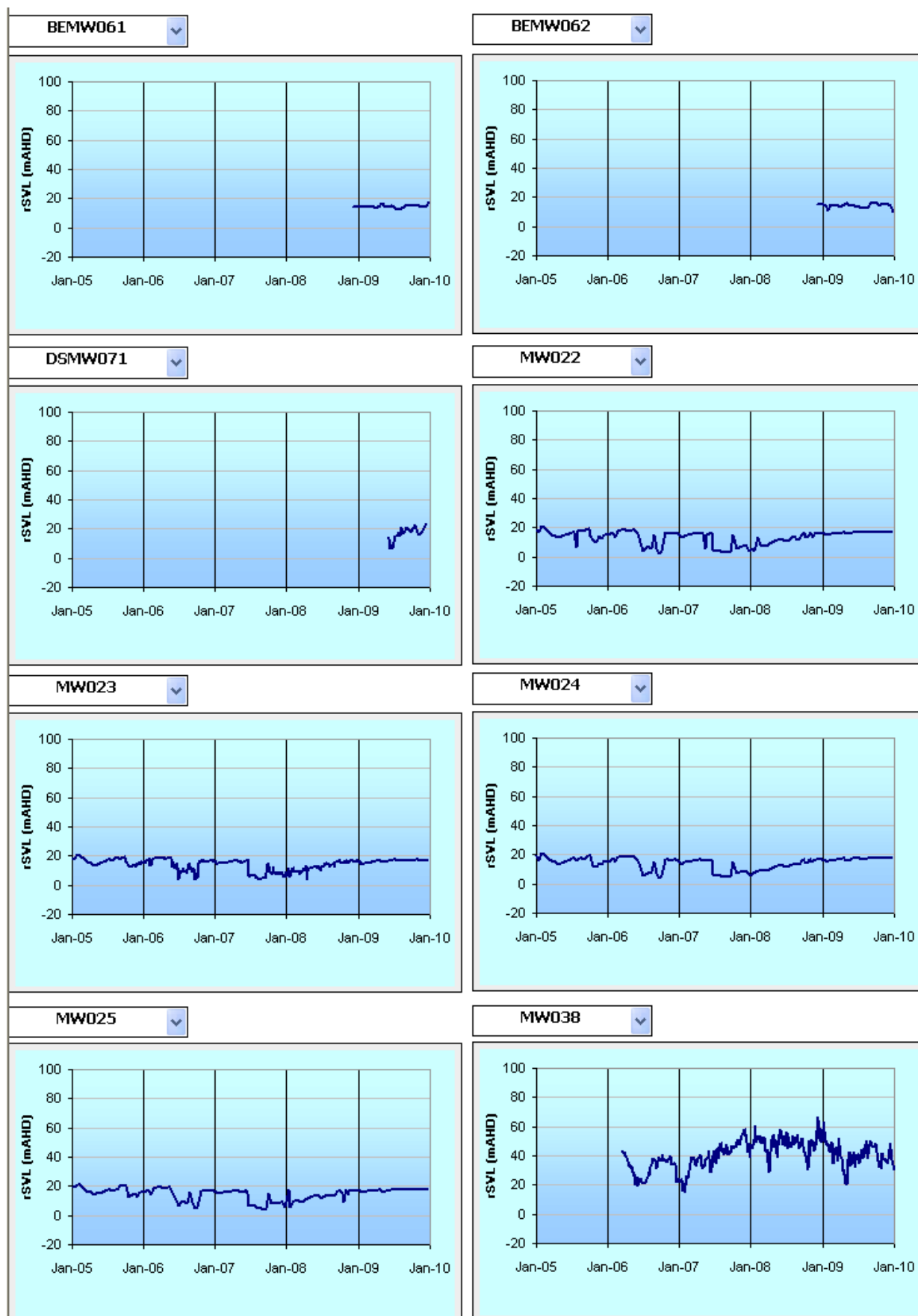
APPENDIX D: Hydrogeological Monitoring Graphs – Namba Formation

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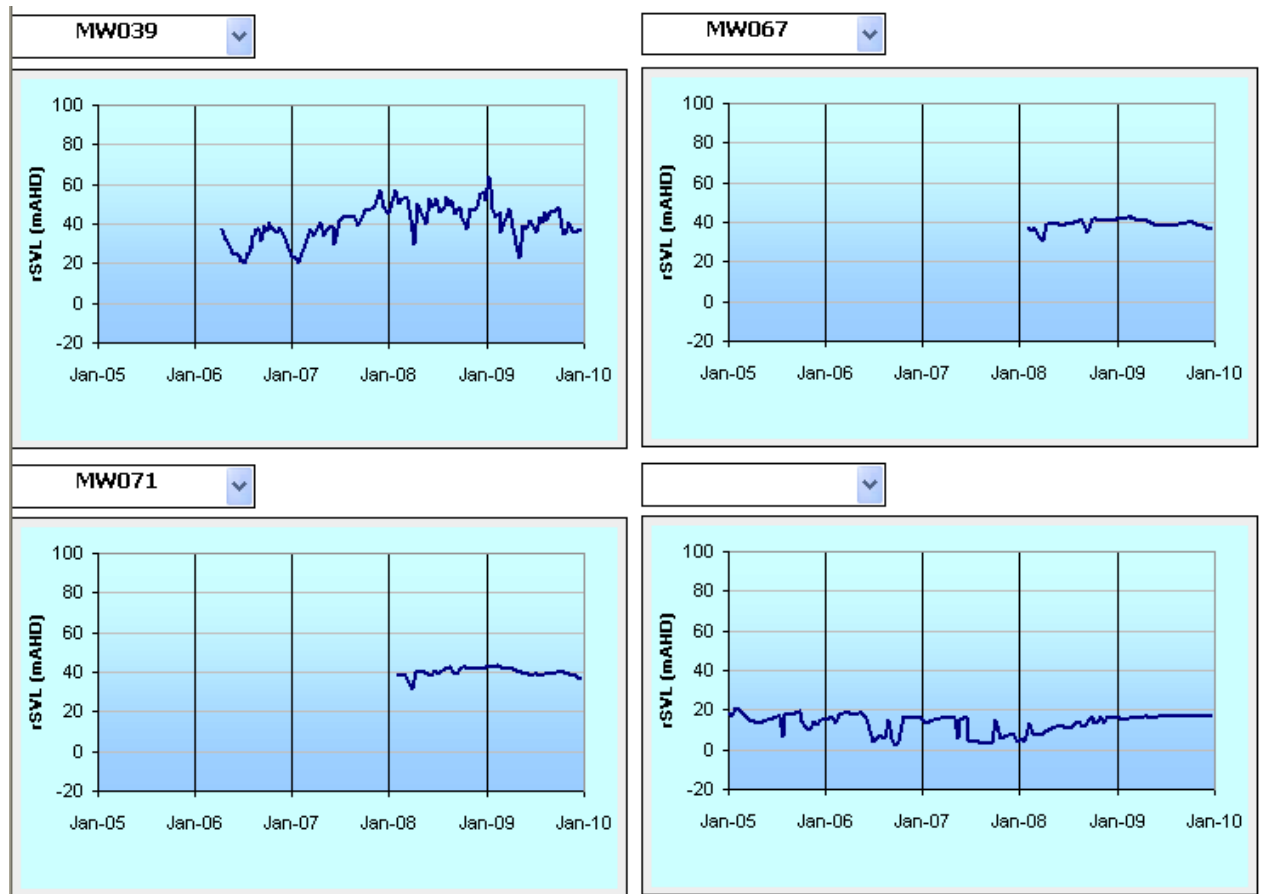
Monitor Well Water Level Graphs – Namba Well Type 1



Monitor Well Water Level Graphs – Namba Well Type 1

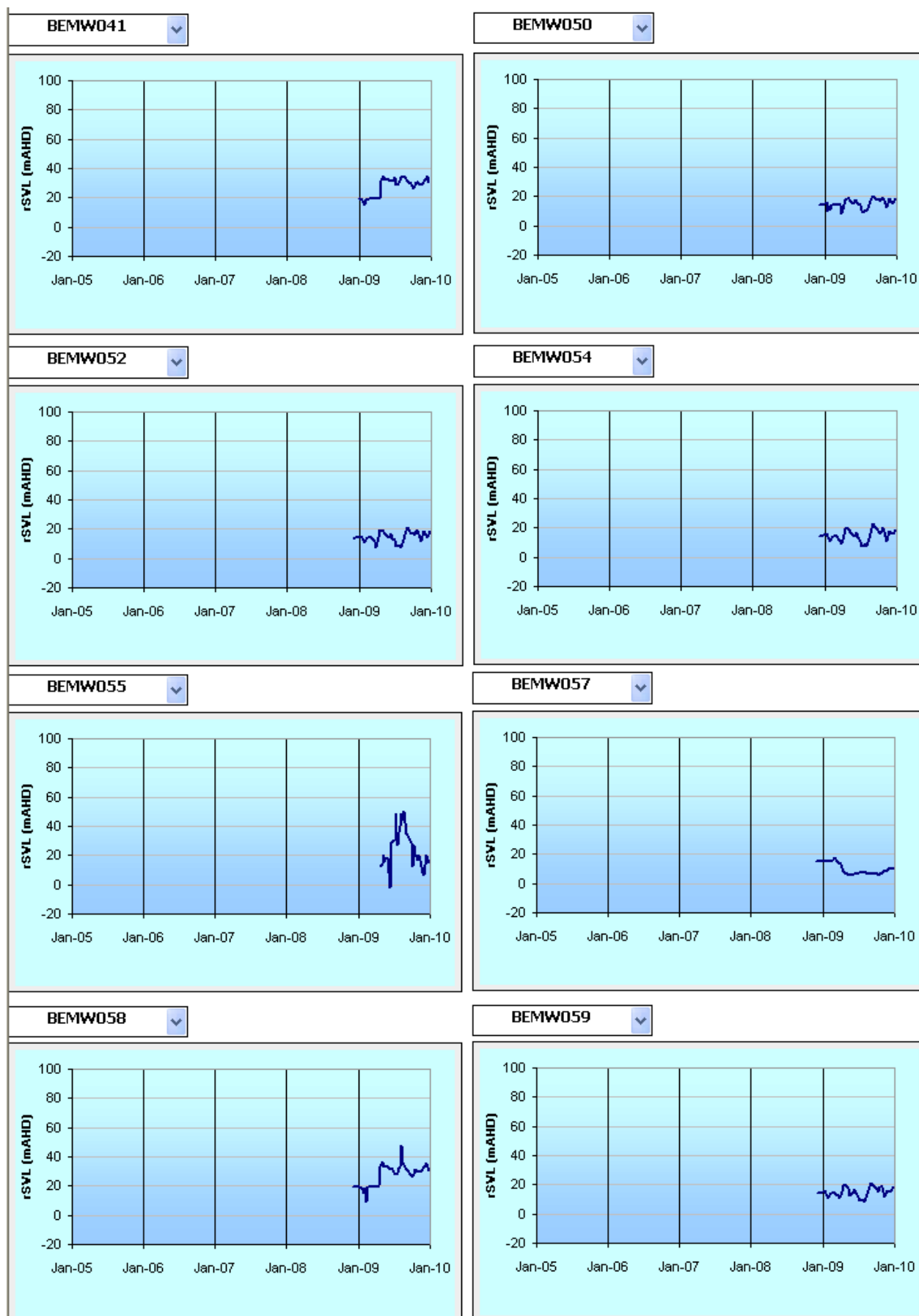


Monitor Well Water Level Graphs – Namba Well Type 1

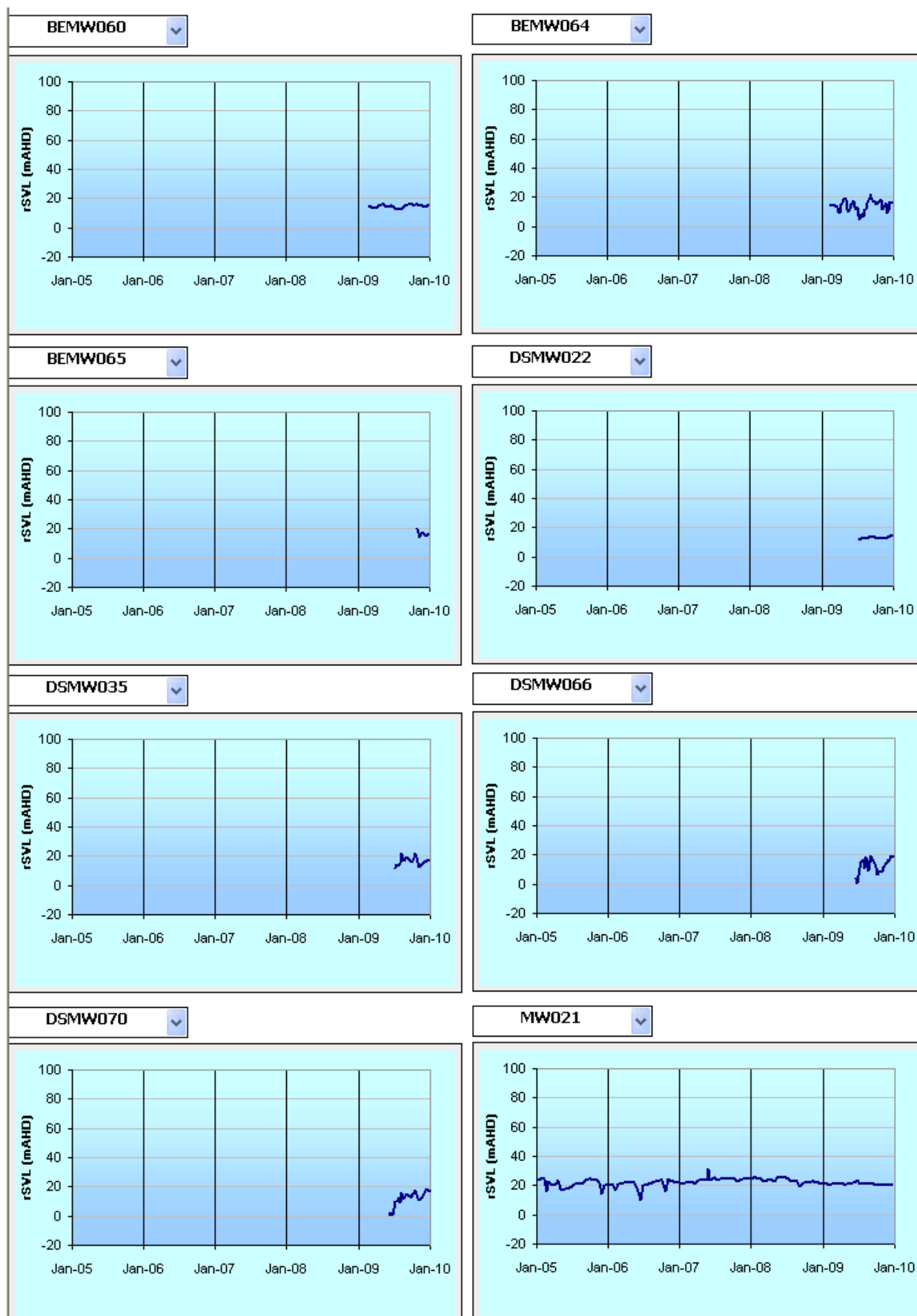


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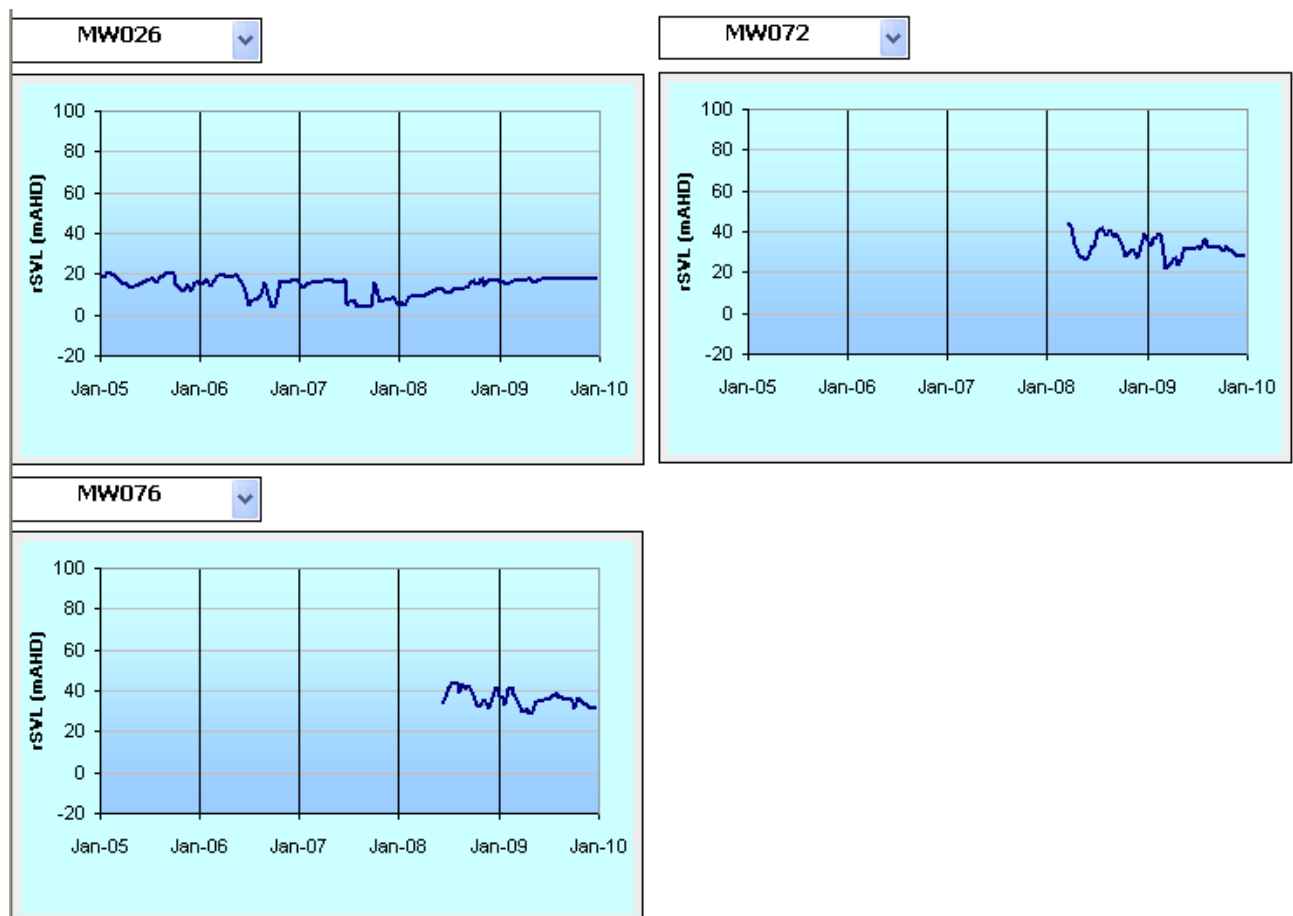
Monitor Well Water Level Graphs – Namba Well Type 2



Monitor Well Water Level Graphs – Namba Well Type 2

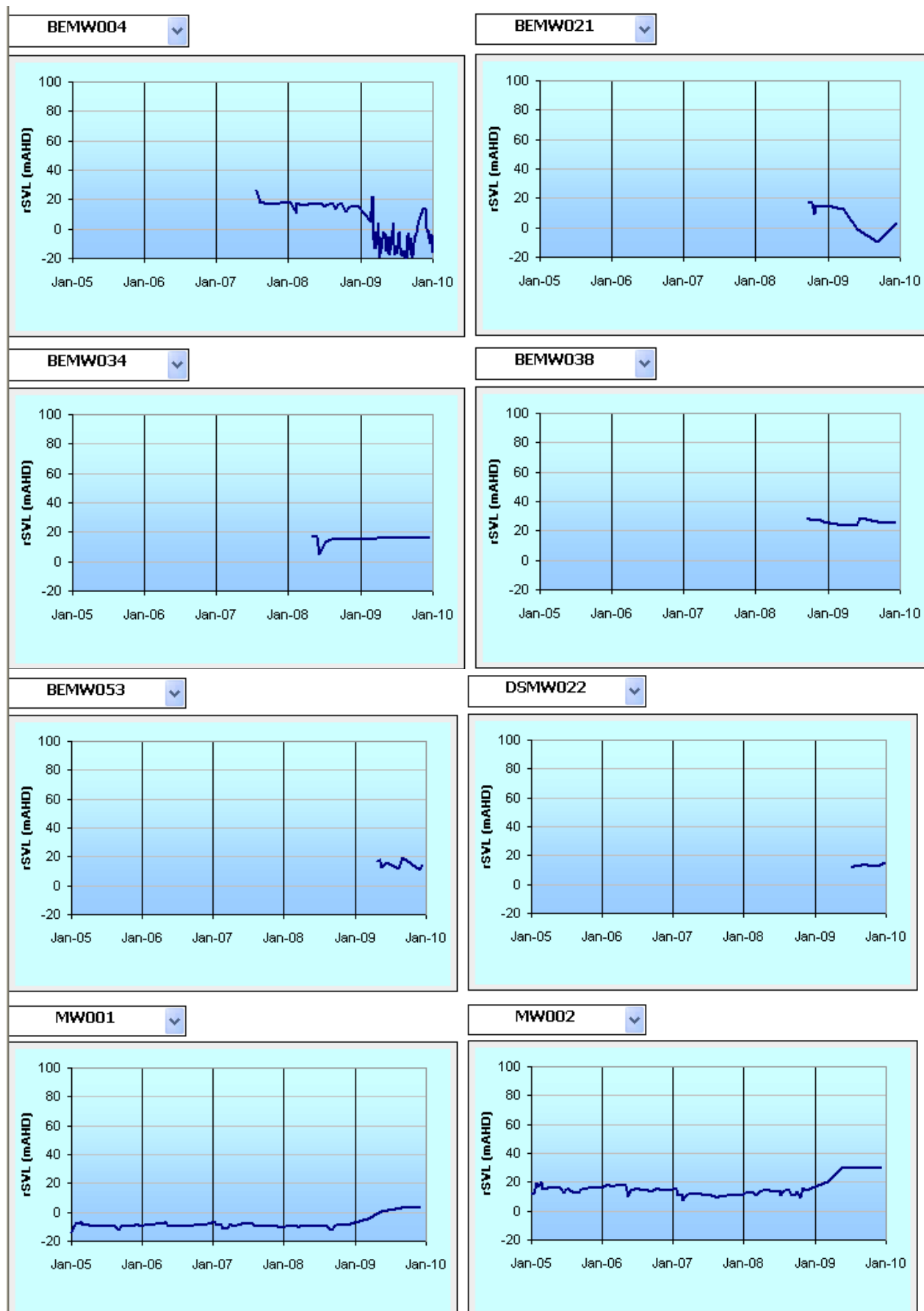


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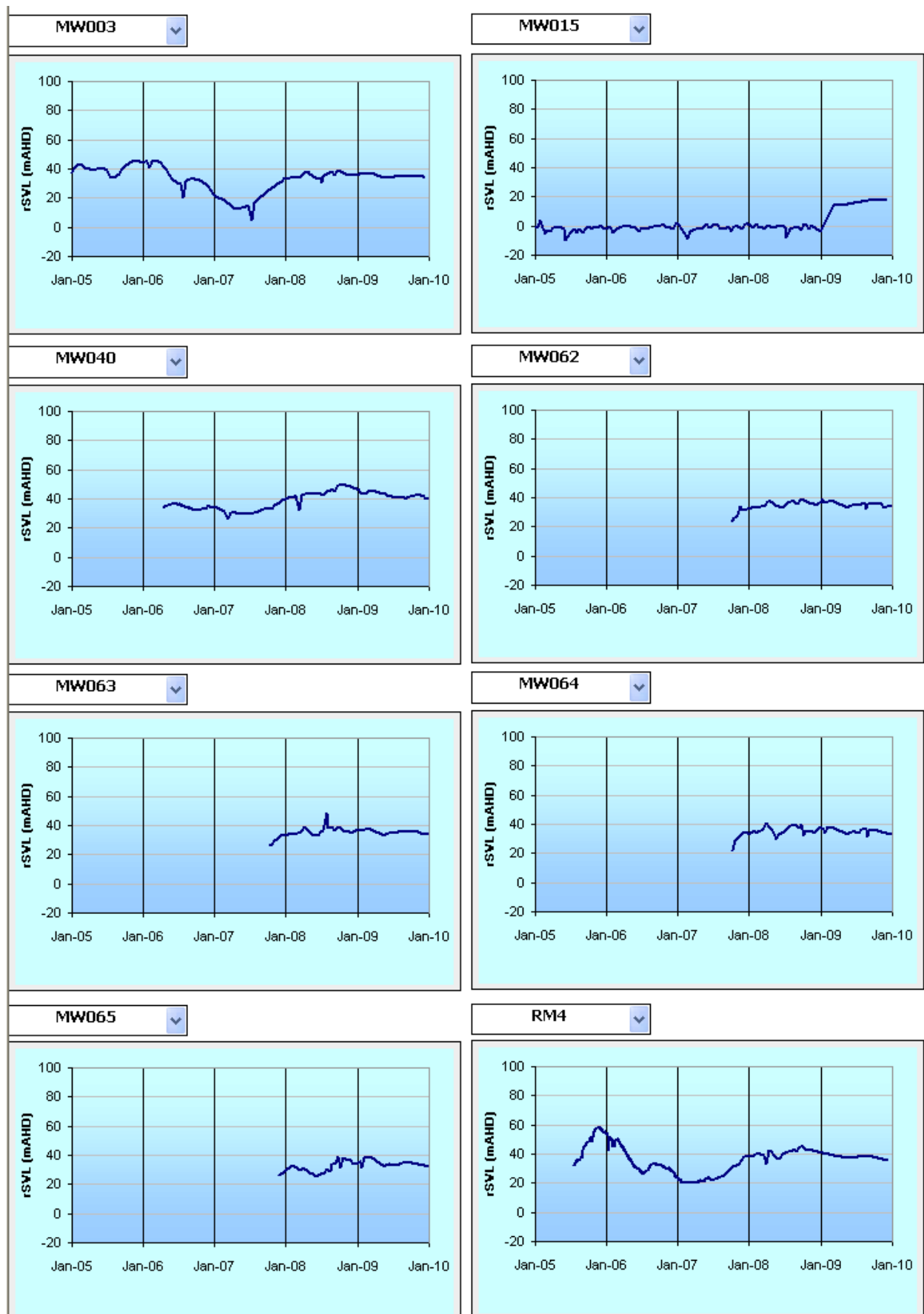


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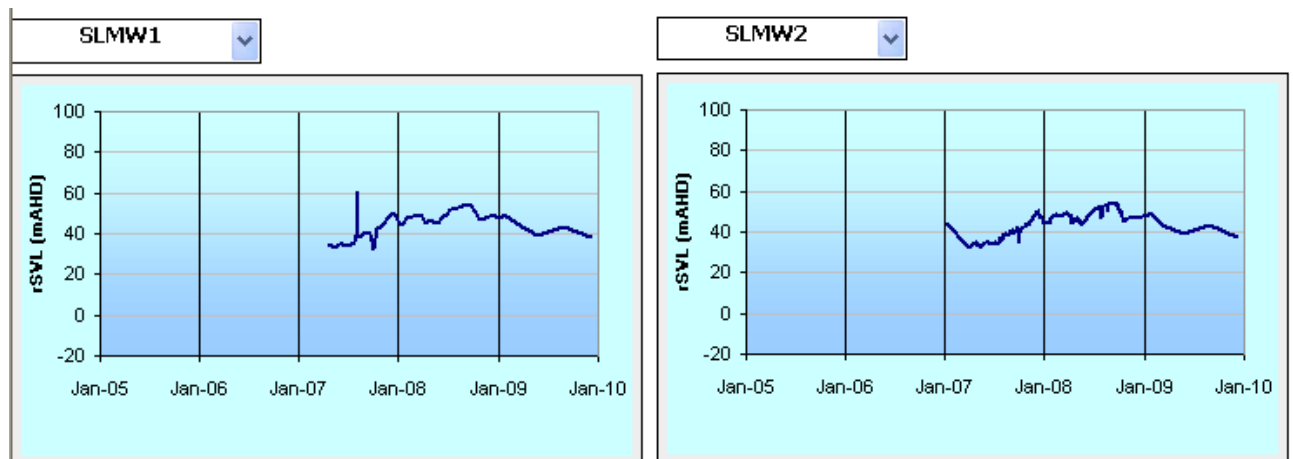
Monitor Well Water Level Graphs – Namba Well Type 3



Monitor Well Water Level Graphs – Namba Well Type 3

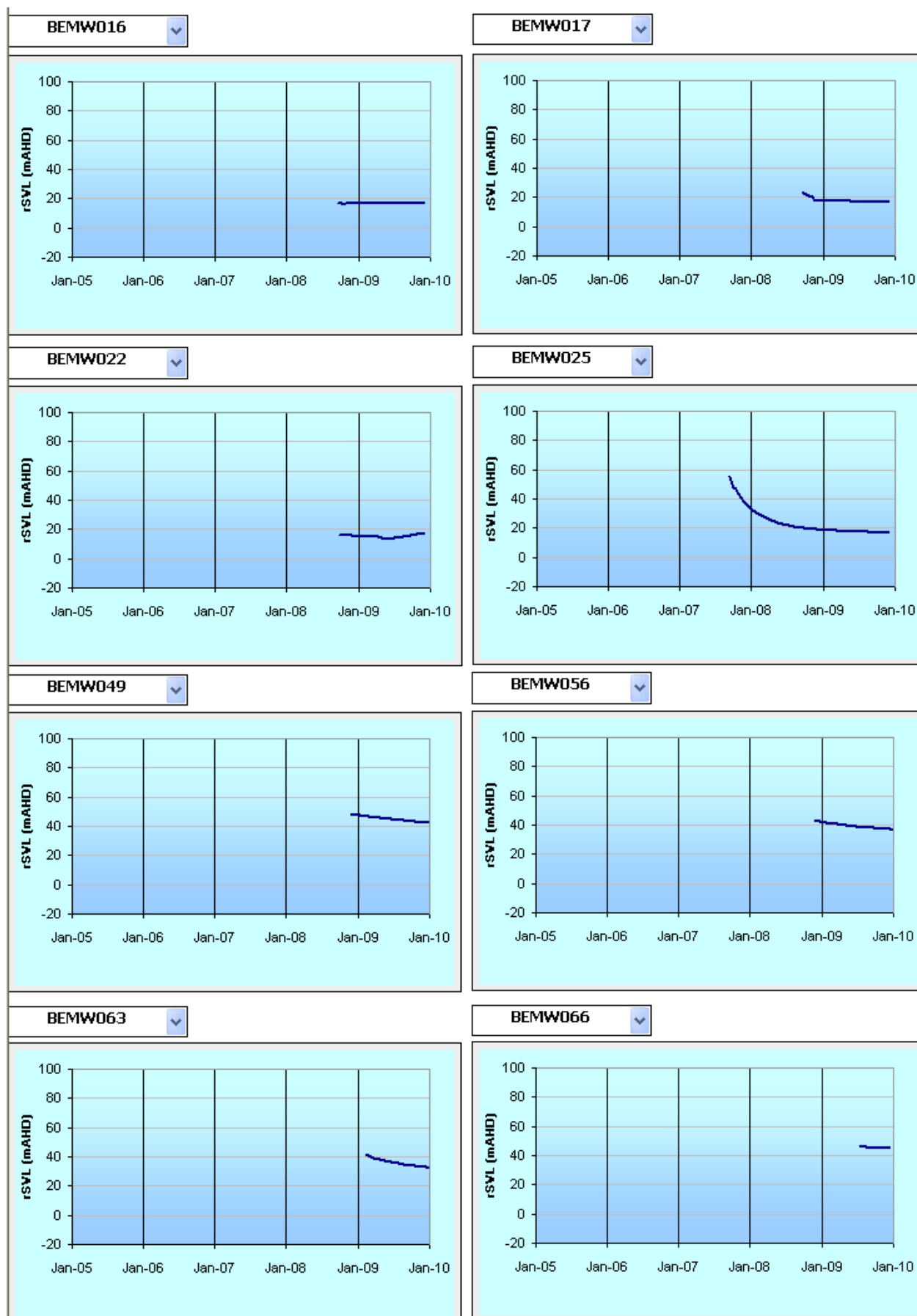


Monitor Well Water Level Graphs – Namba Well Type 3

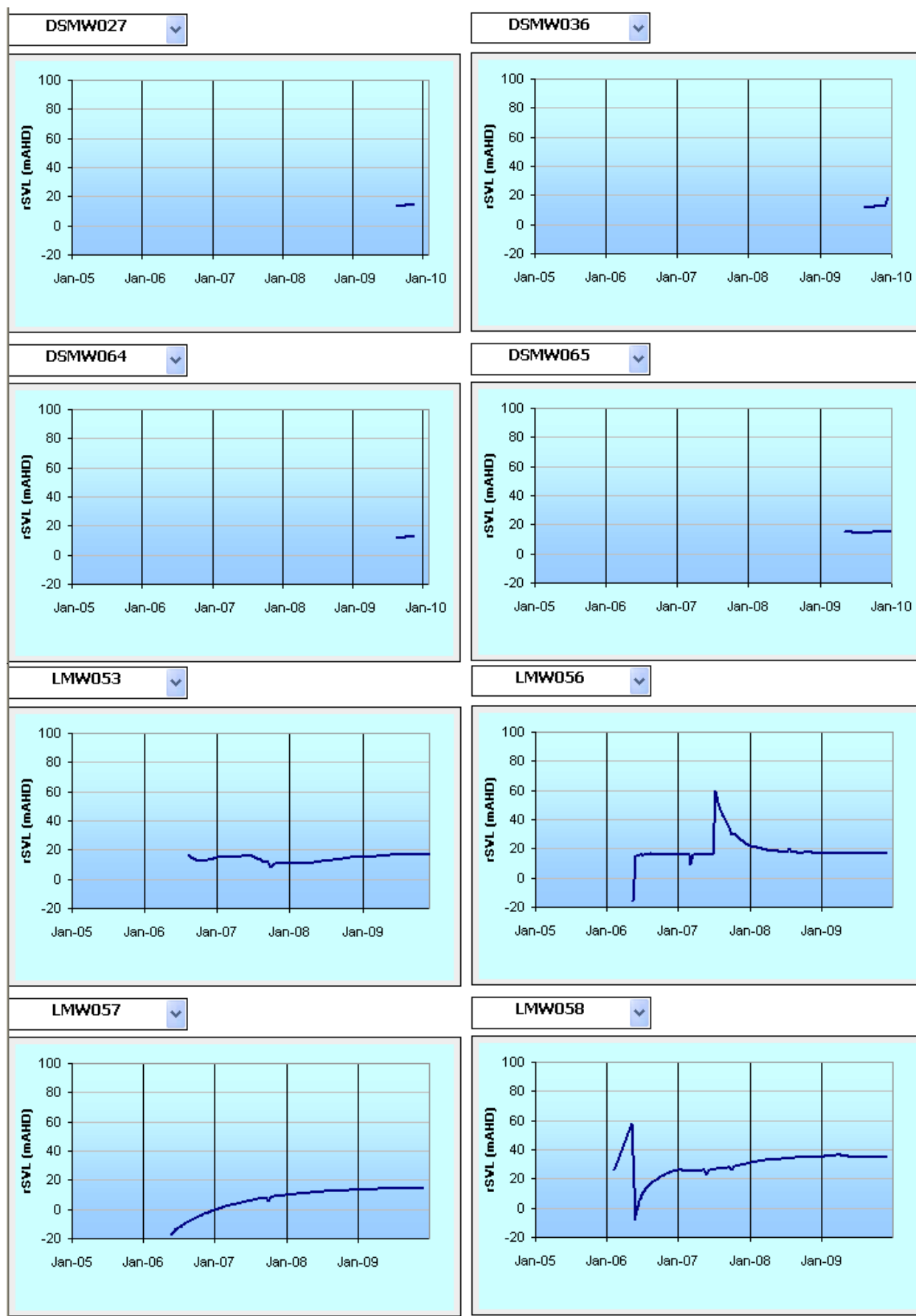


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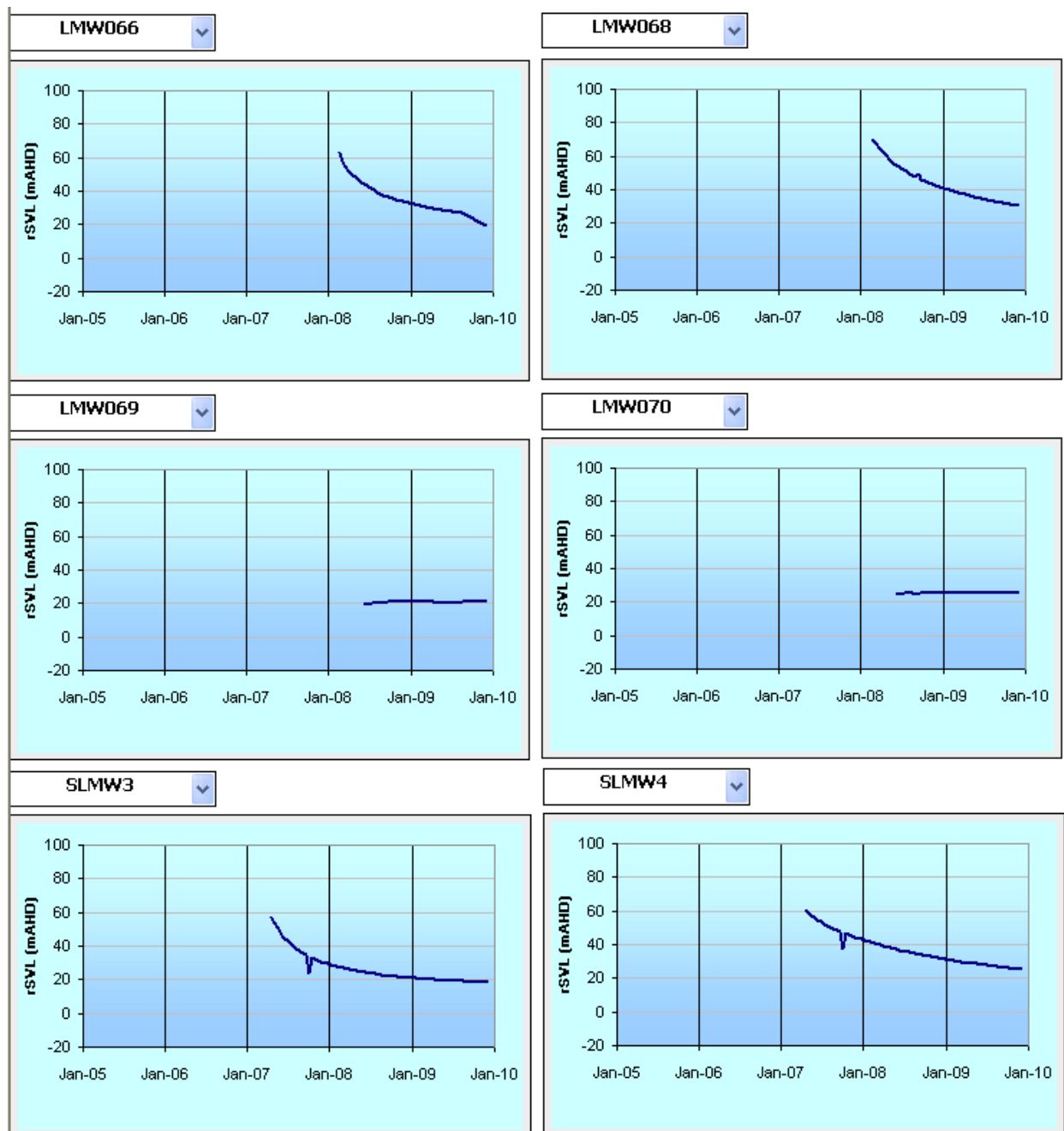
Monitor Well Water Level Graphs – Namba Well Type 4



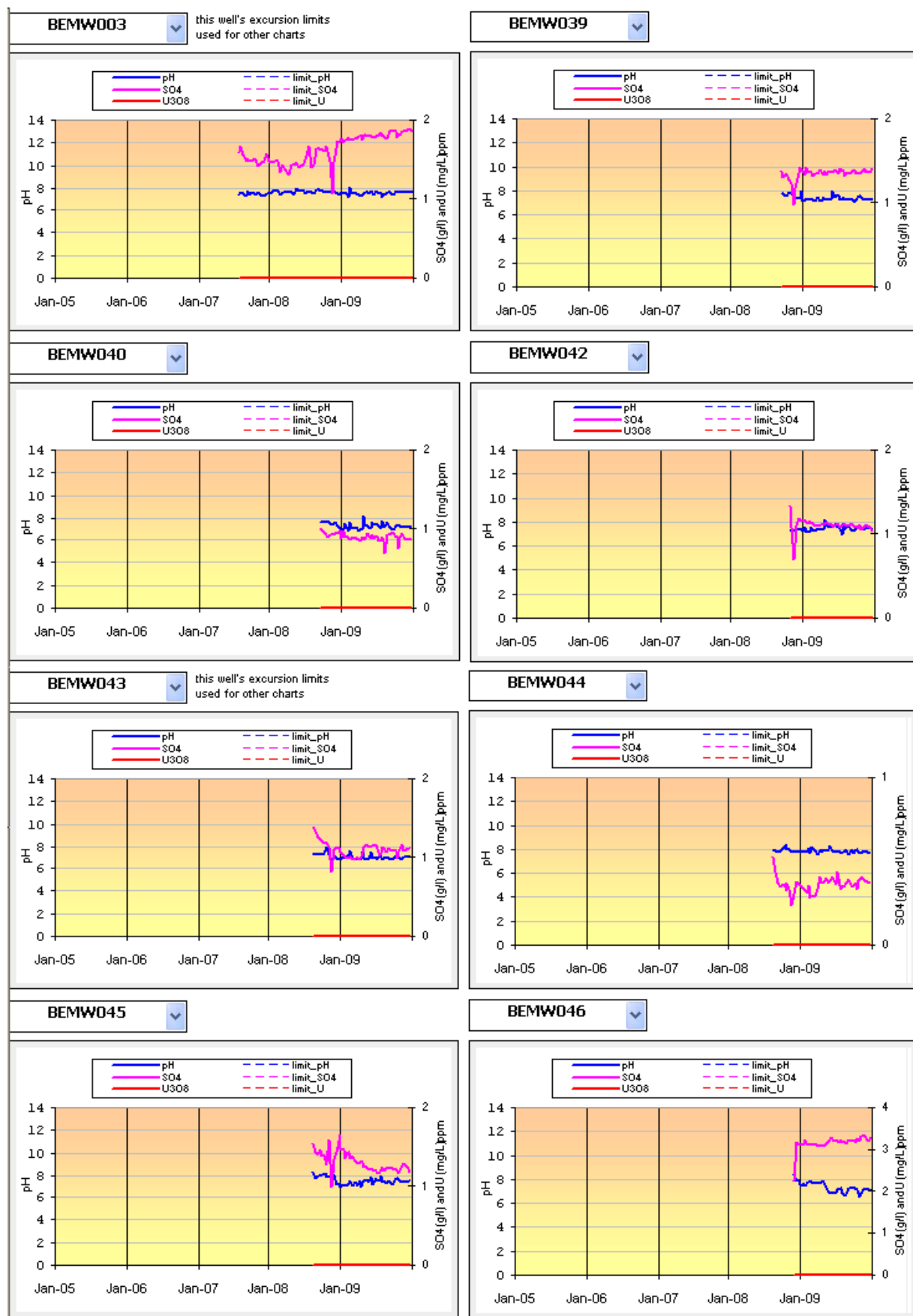
Monitor Well Water Level Graphs – Namba Well Type 4



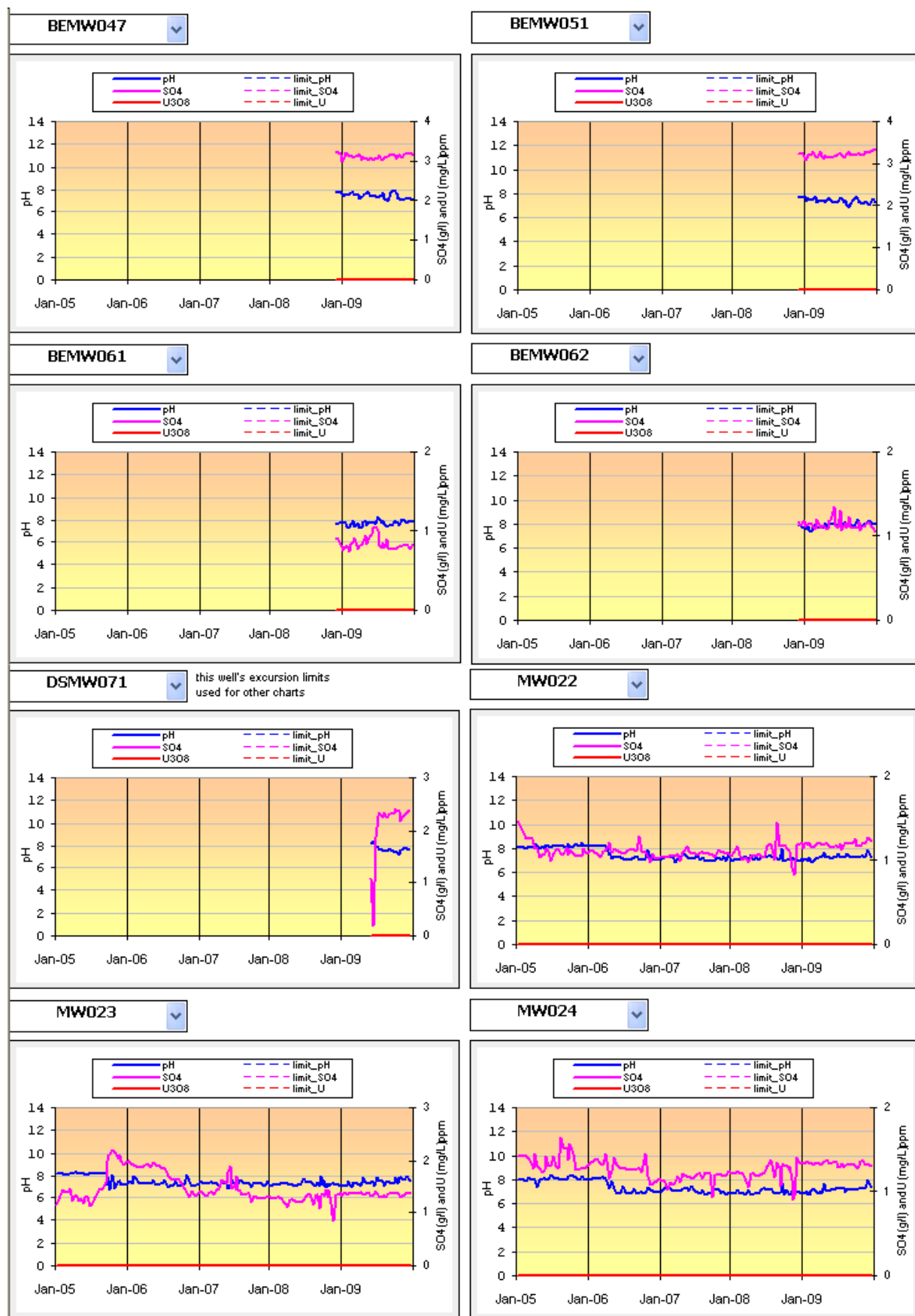
Monitor Well Water Level Graphs – Namba Well Type 4



Monitor Well Water Chemistry – Namba Well Type 1

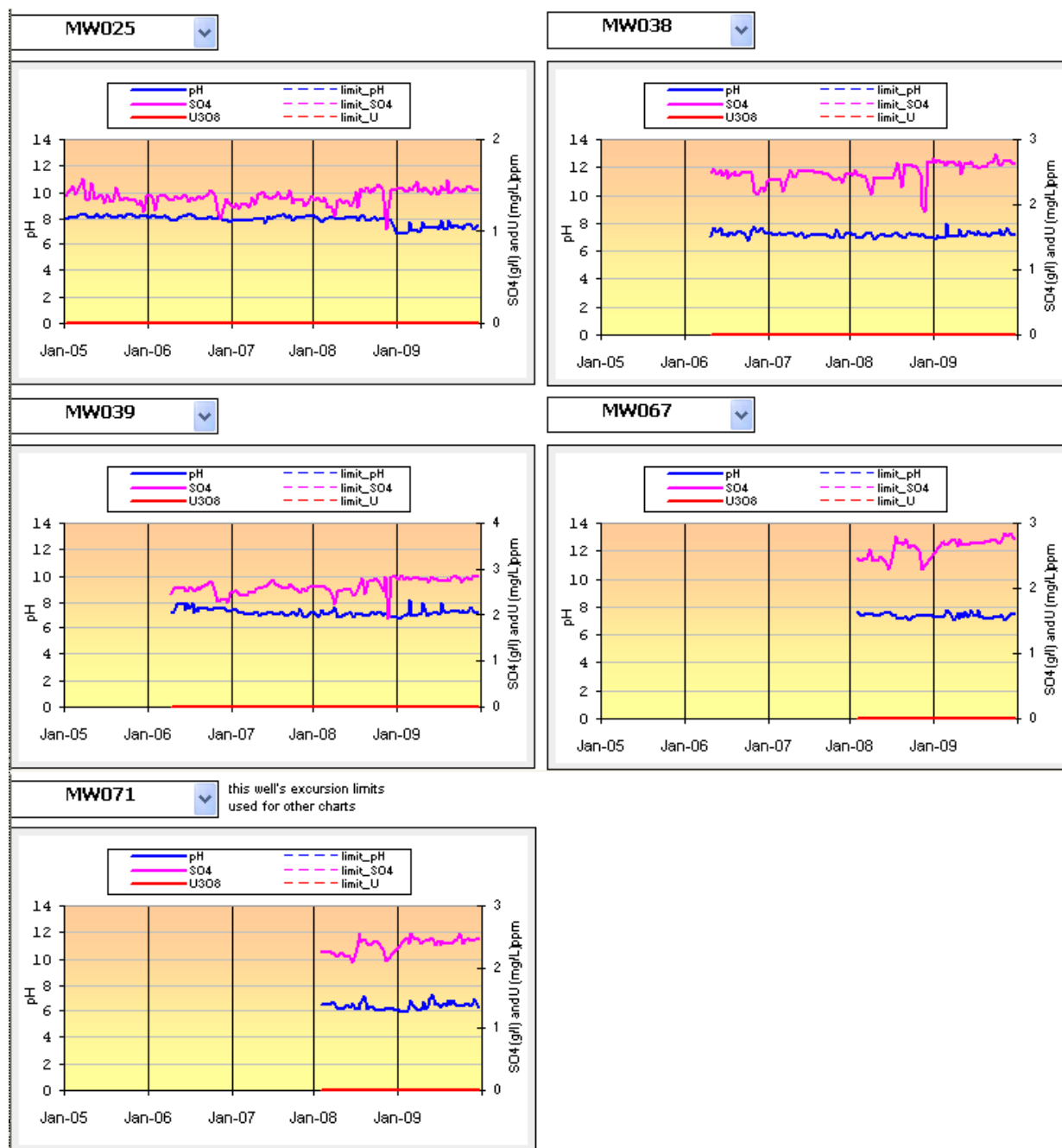


Monitor Well Water Chemistry – Namba Well Type 1

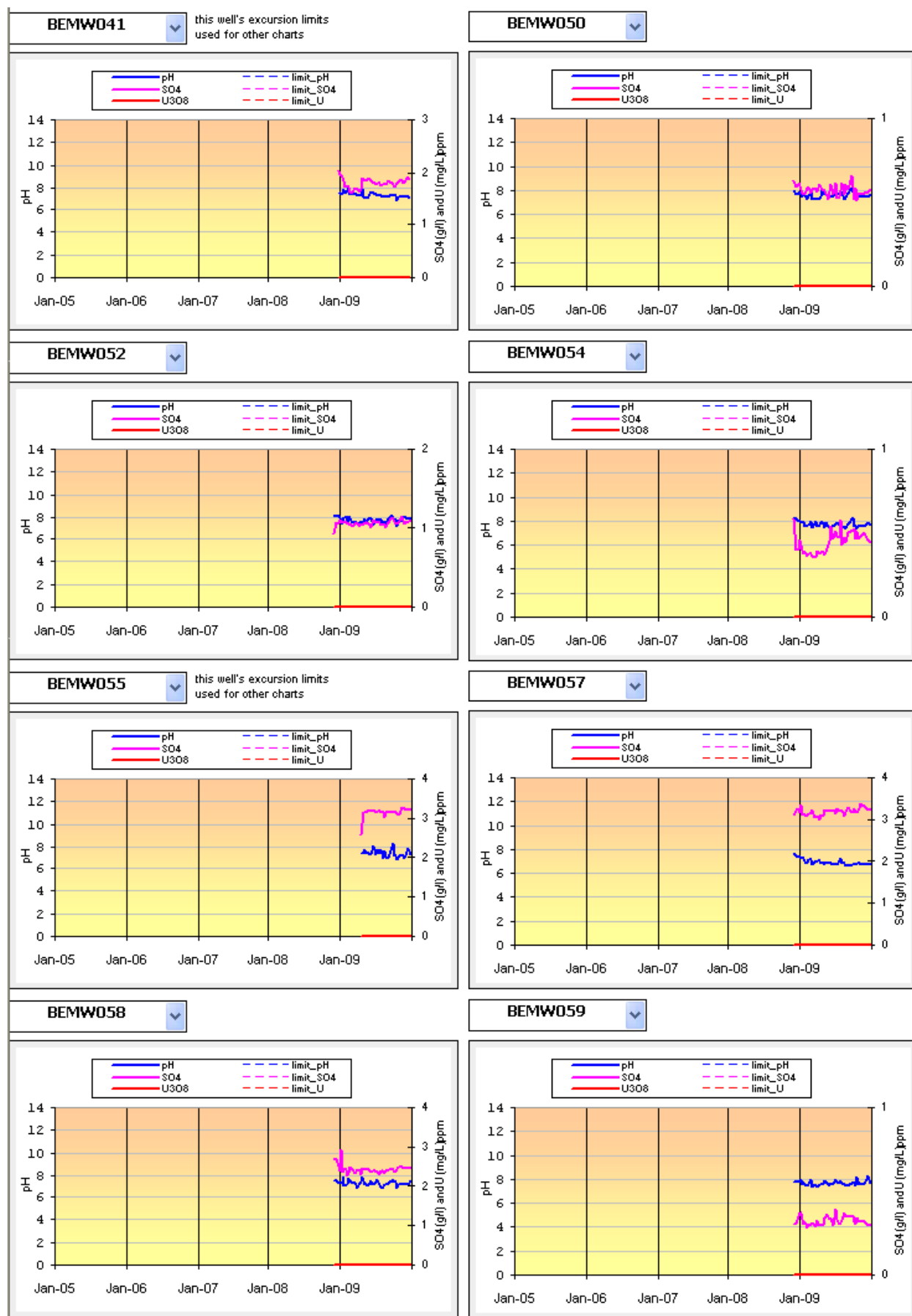


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Monitor Well Water Chemistry – Namba Well Type 1

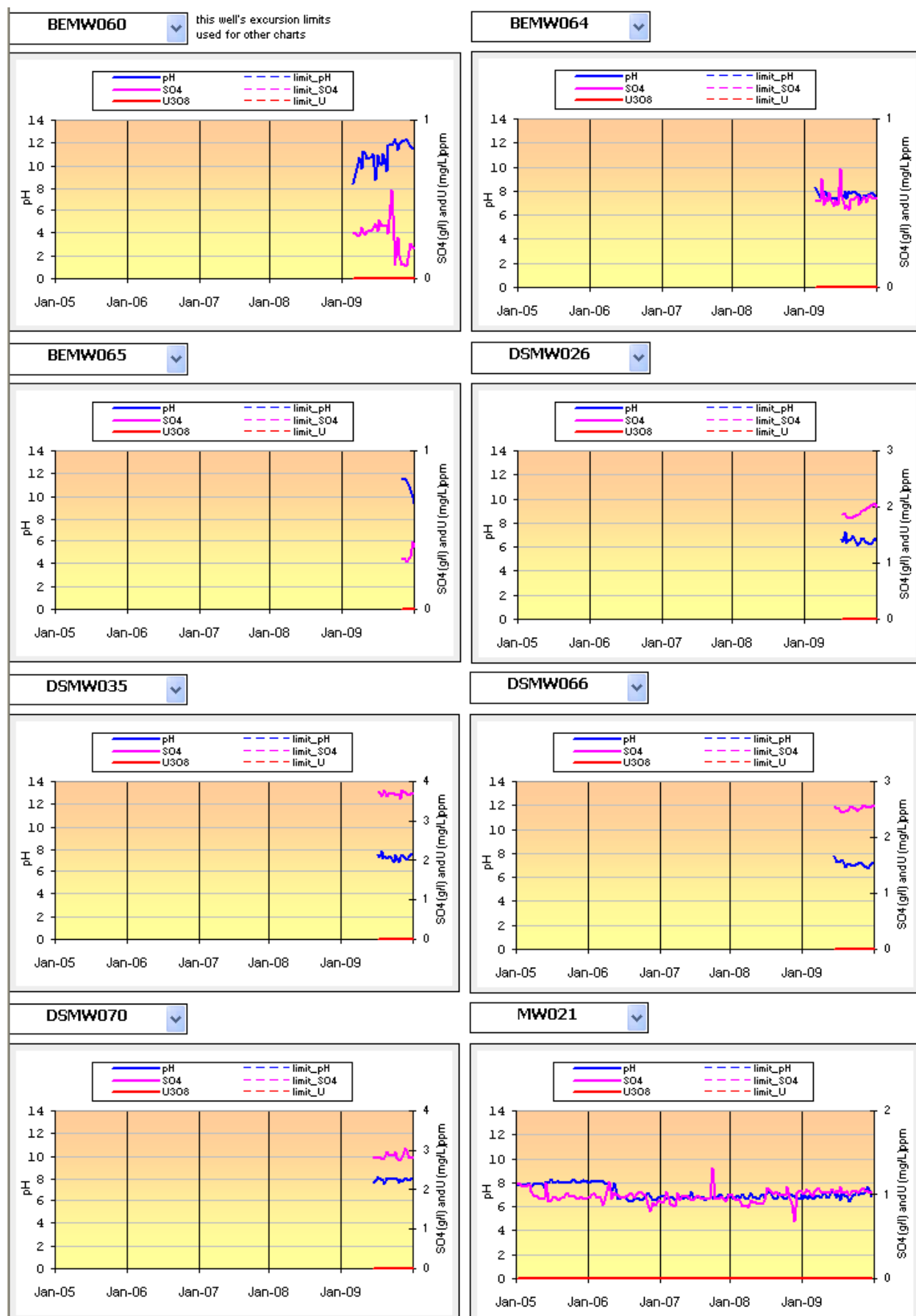


Monitor Well Water Chemistry – Namba Well Type 2



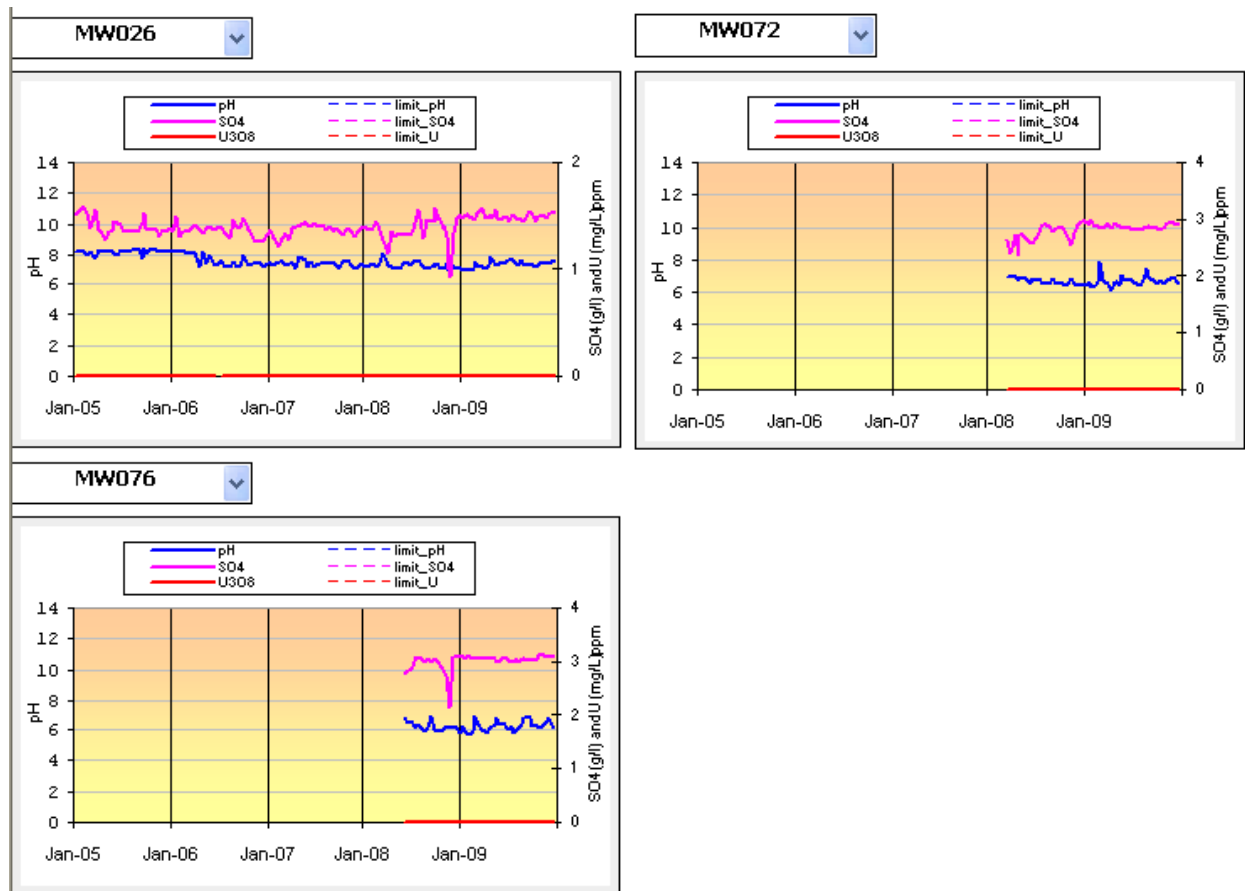
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Monitor Well Water Chemistry – Namba Well Type 2



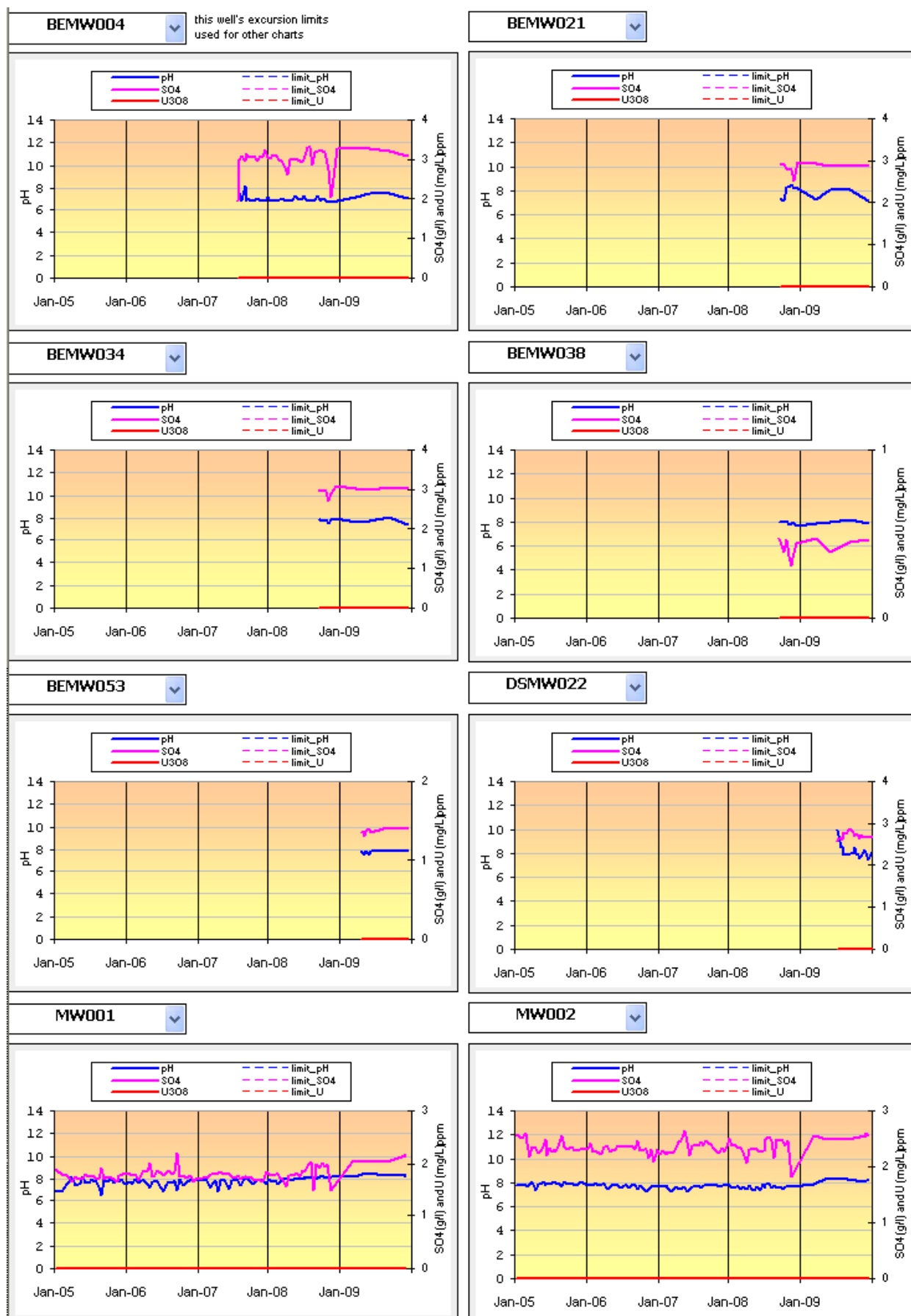
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Monitor Well Water Chemistry – Namba Well Type 2



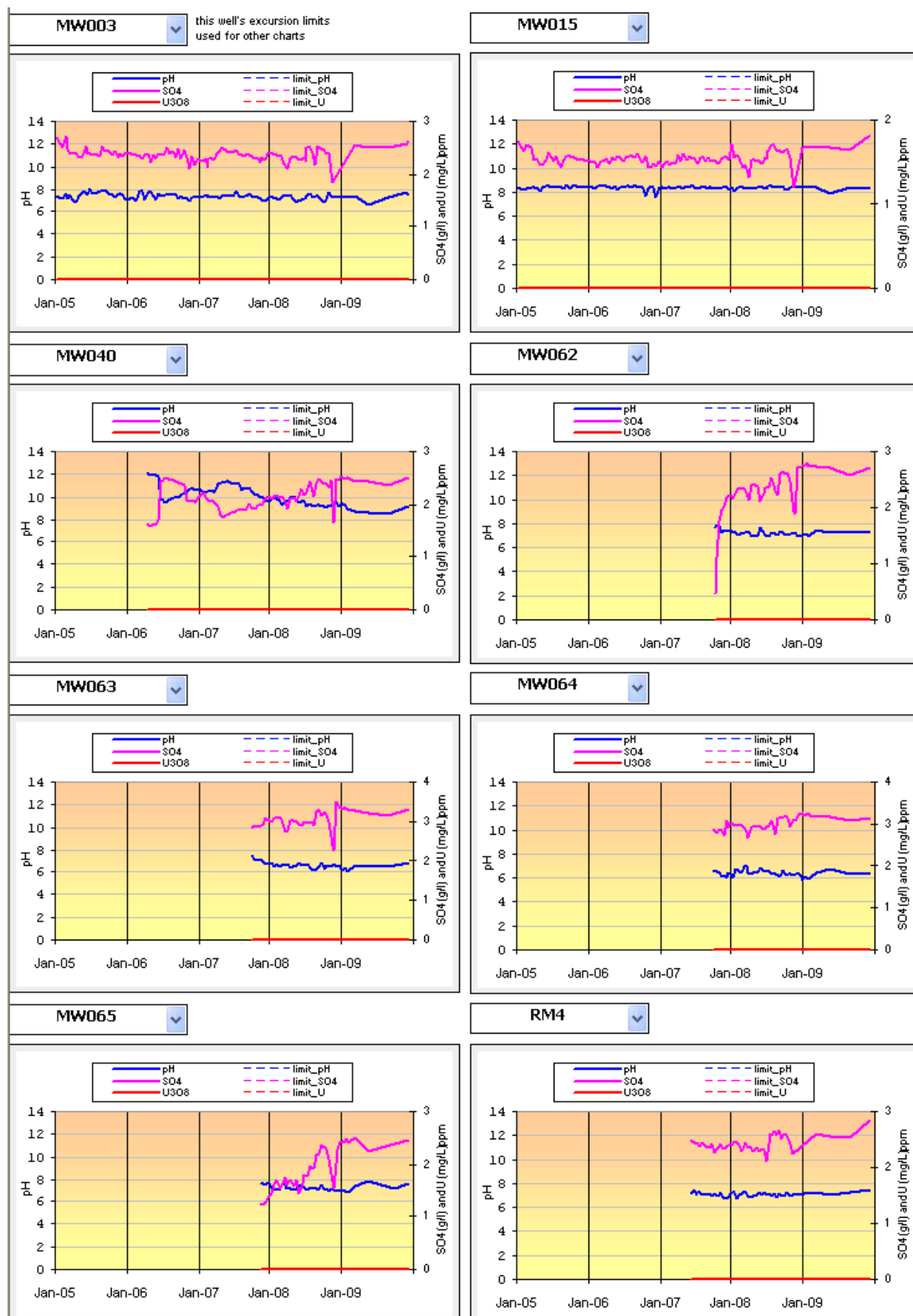
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Monitor Well Water Chemistry – Namba Well Type 3



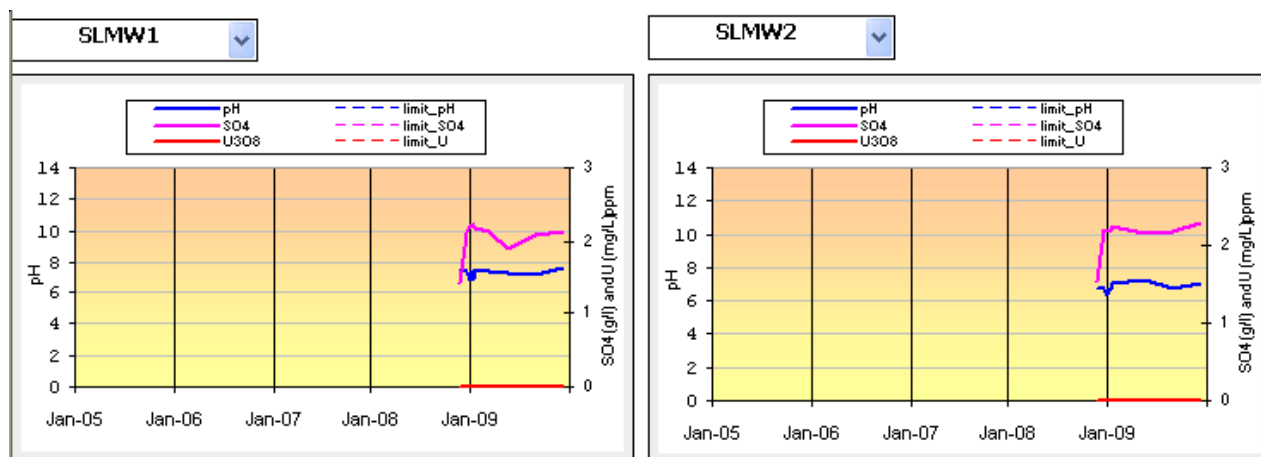
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Monitor Well Water Chemistry – Namba Well Type 3



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Monitor Well Water Chemistry – Namba Well Type 3

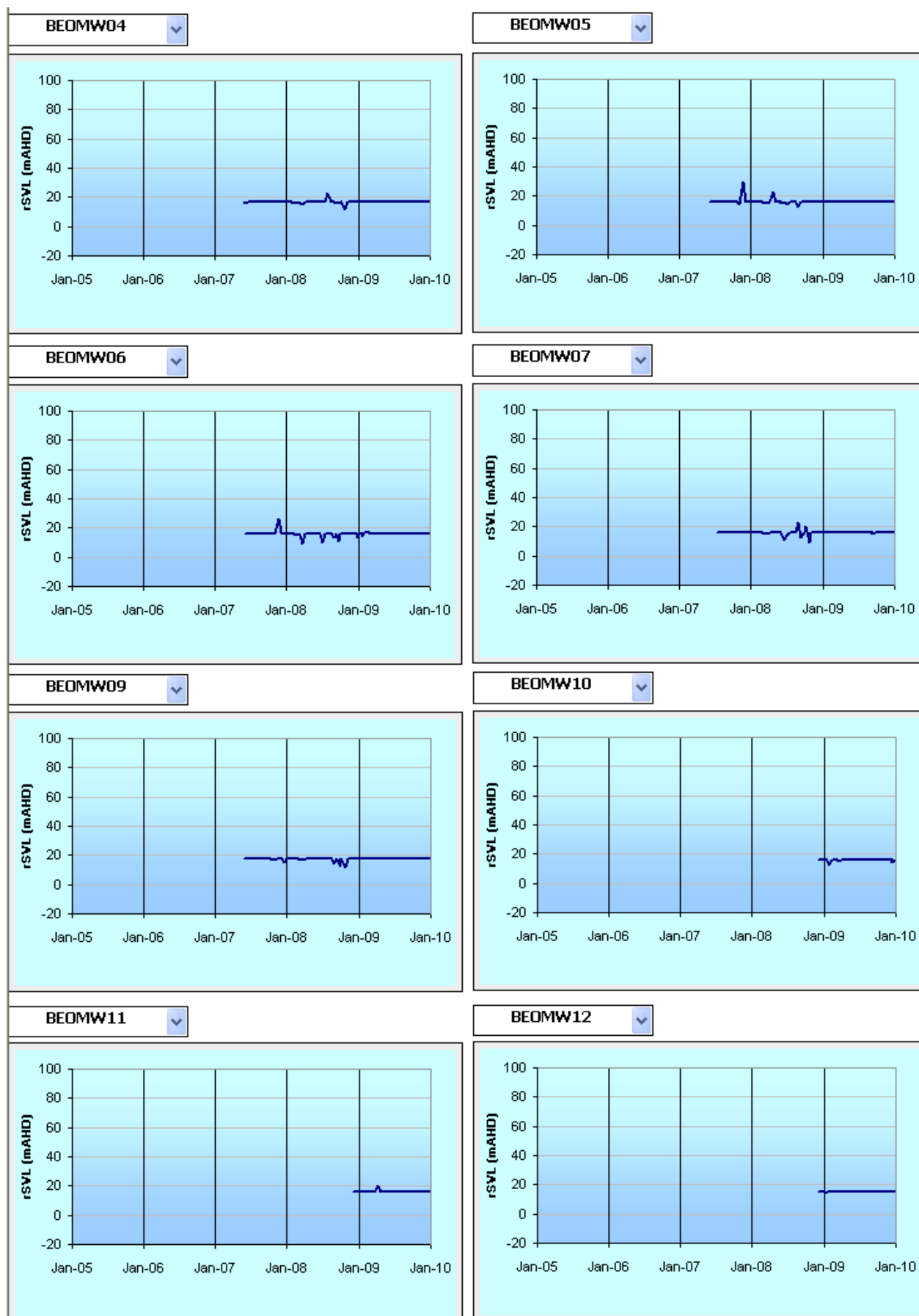


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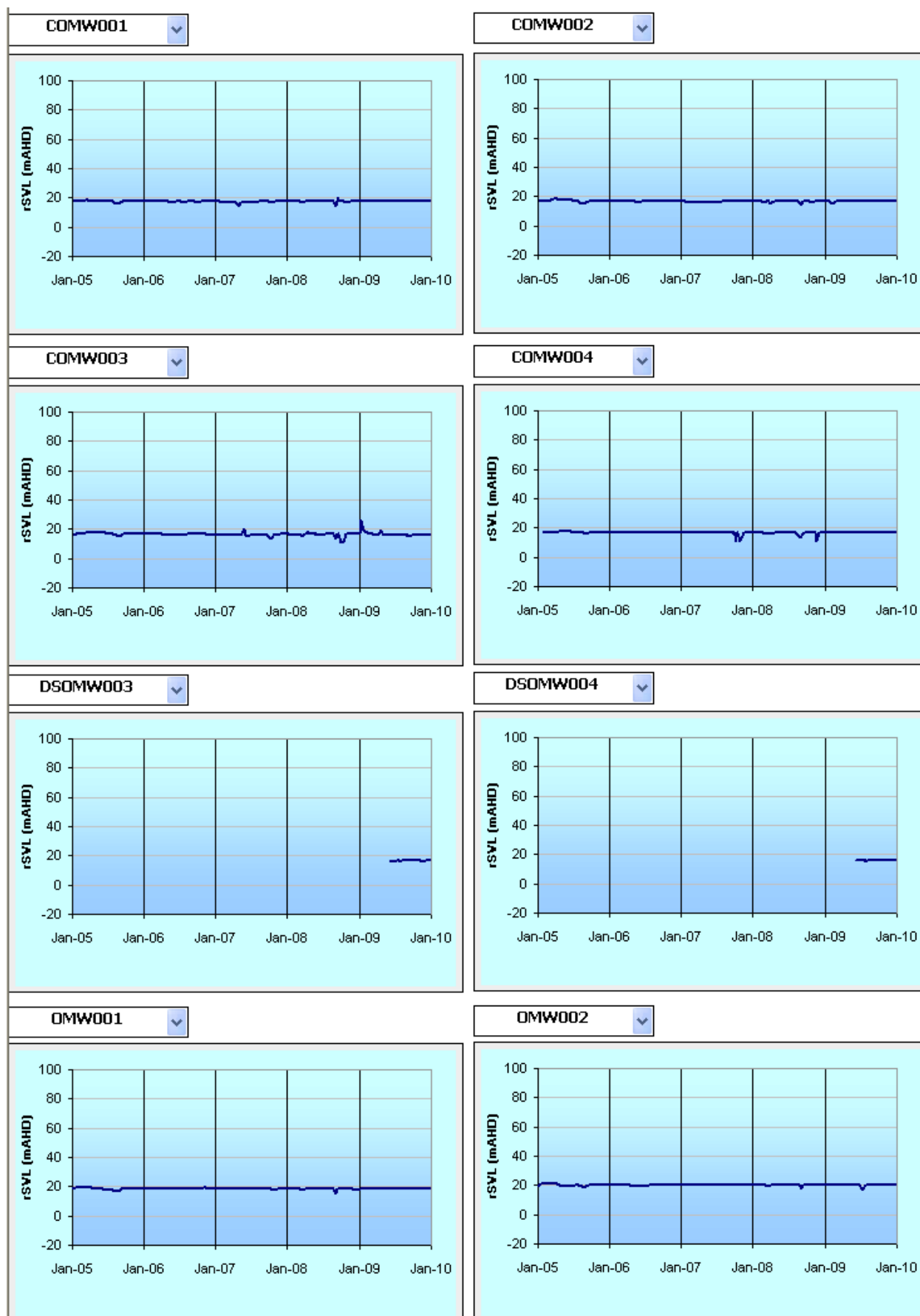
APPENDIX E: Hydrogeological Monitoring Graphs – Willawortina Formation

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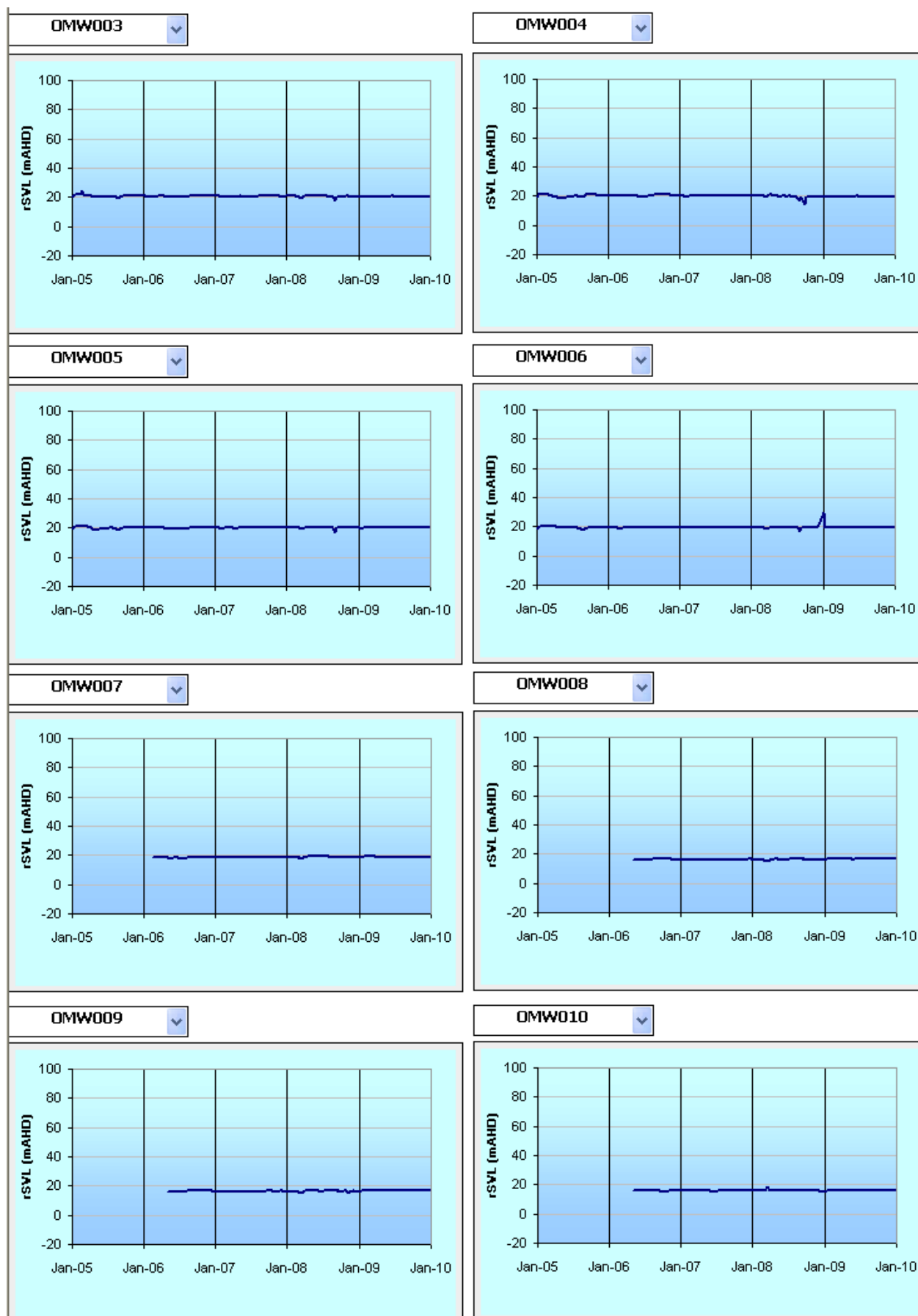
Monitor Well Water Level Graphs – Overlying



Monitor Well Water Level Graphs – Overlying

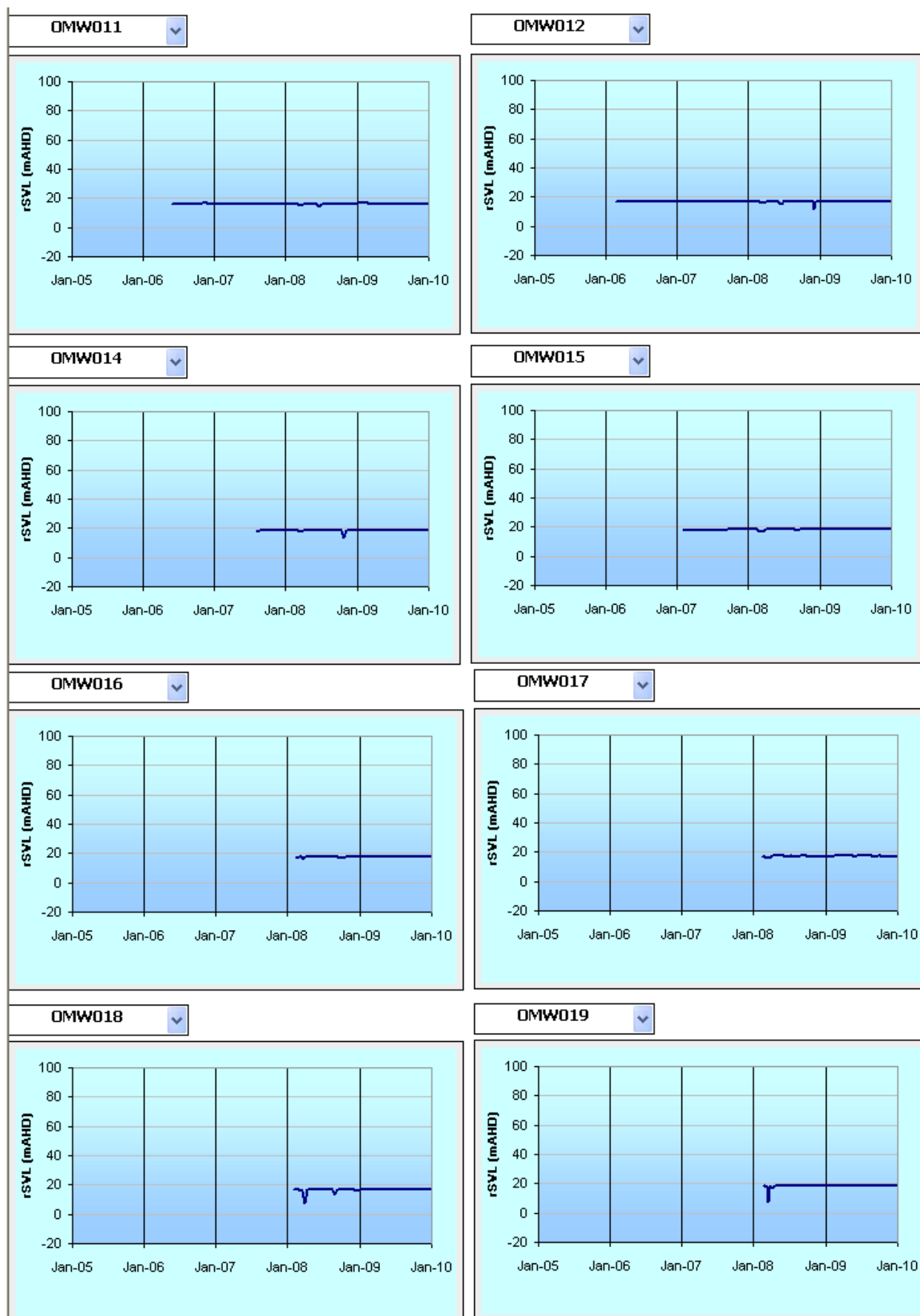


Monitor Well Water Level Graphs – Overlying

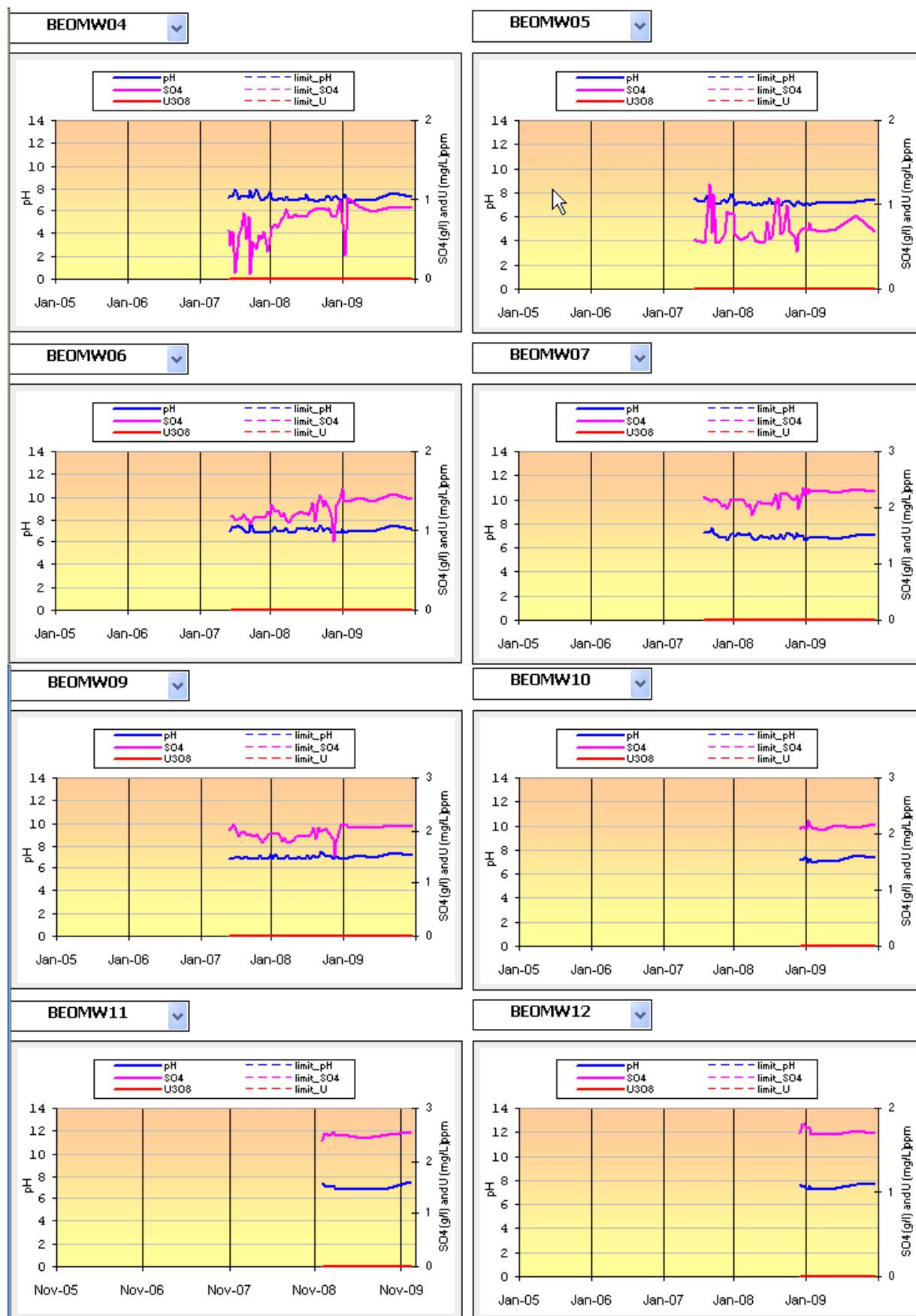


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Monitor Well Water Level Graphs – Overlying

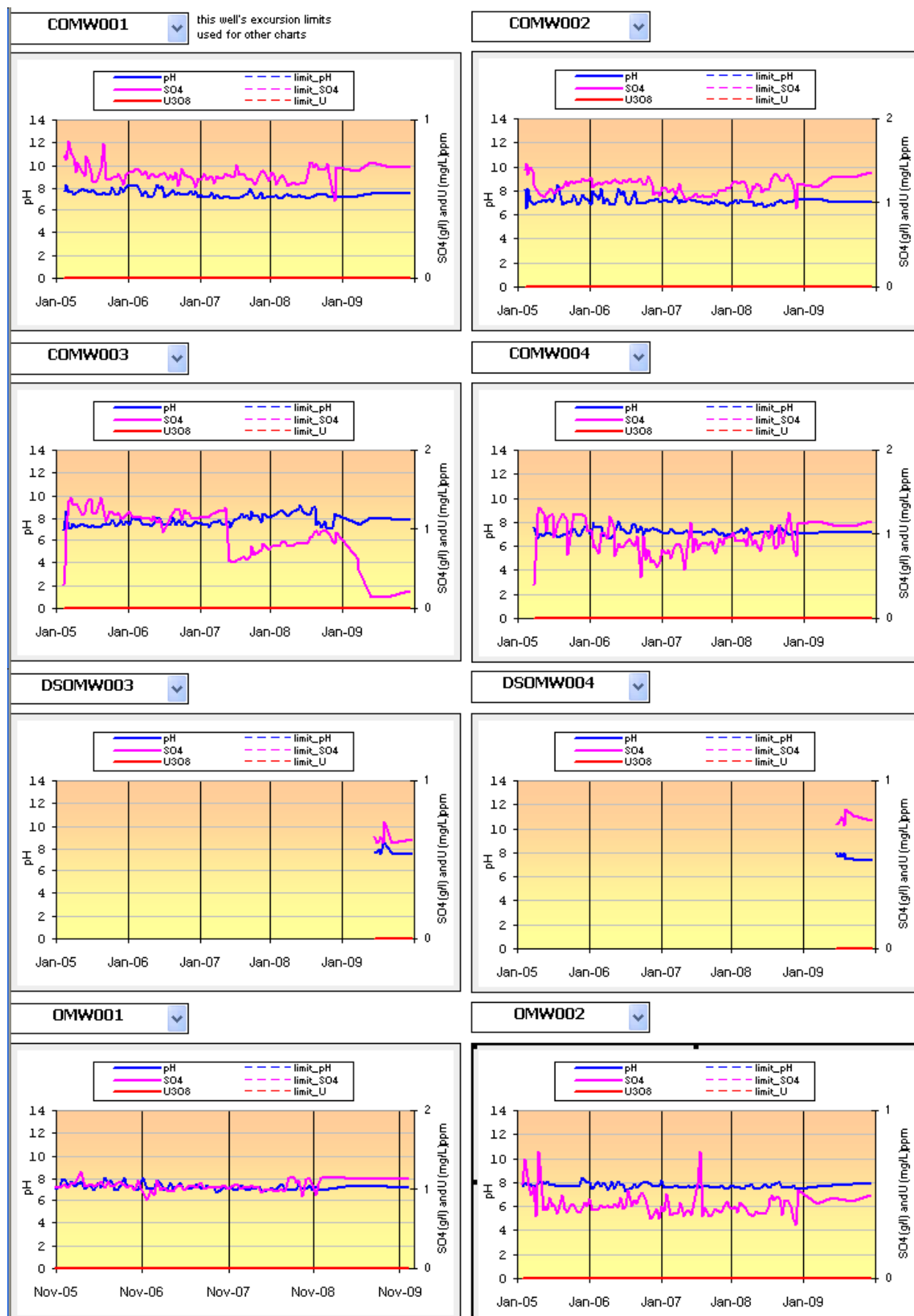


Monitor Well Water Chemistry – Overlying



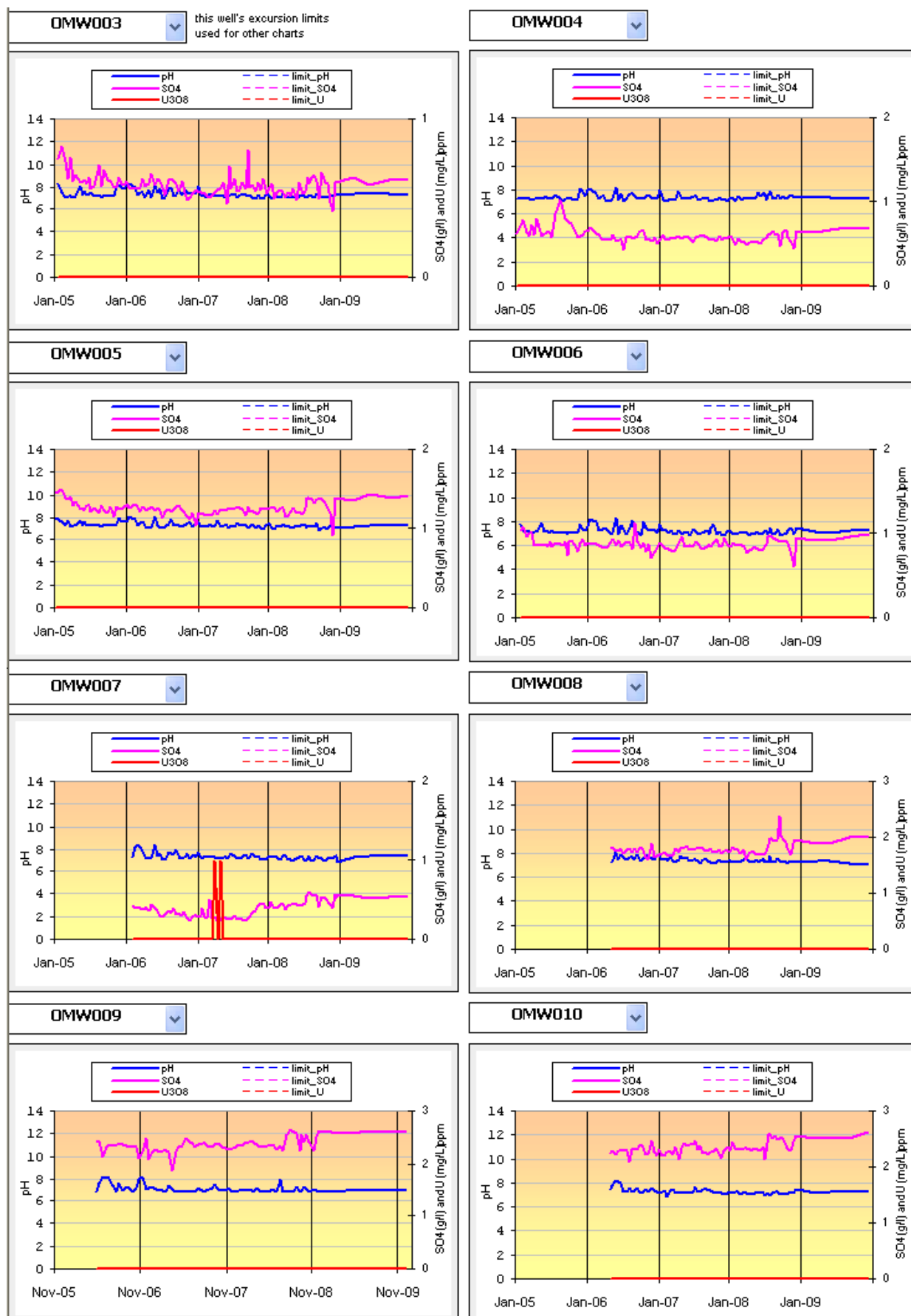
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Monitor Well Water Chemistry – Overlying



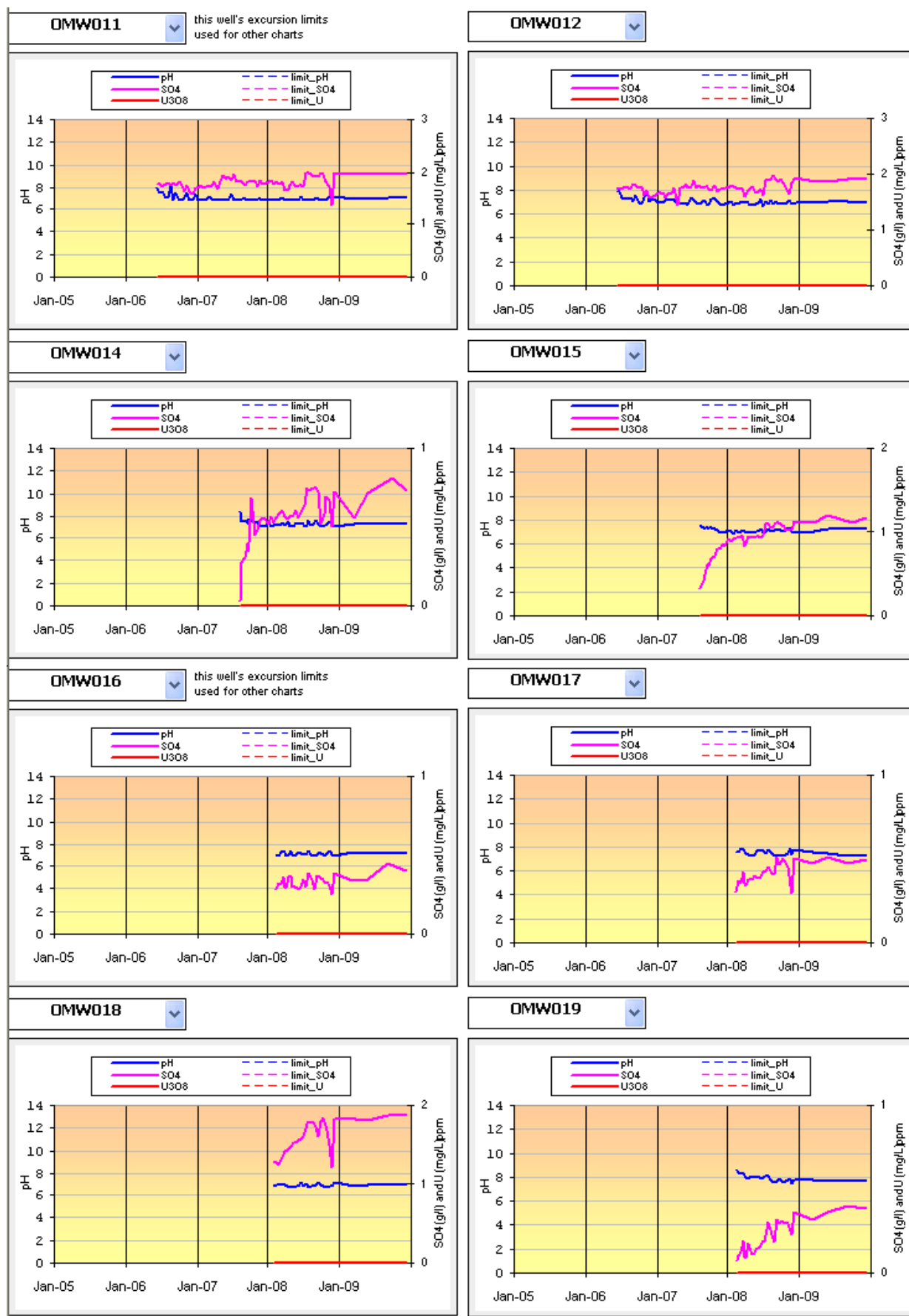
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Monitor Well Water Chemistry – Overlying



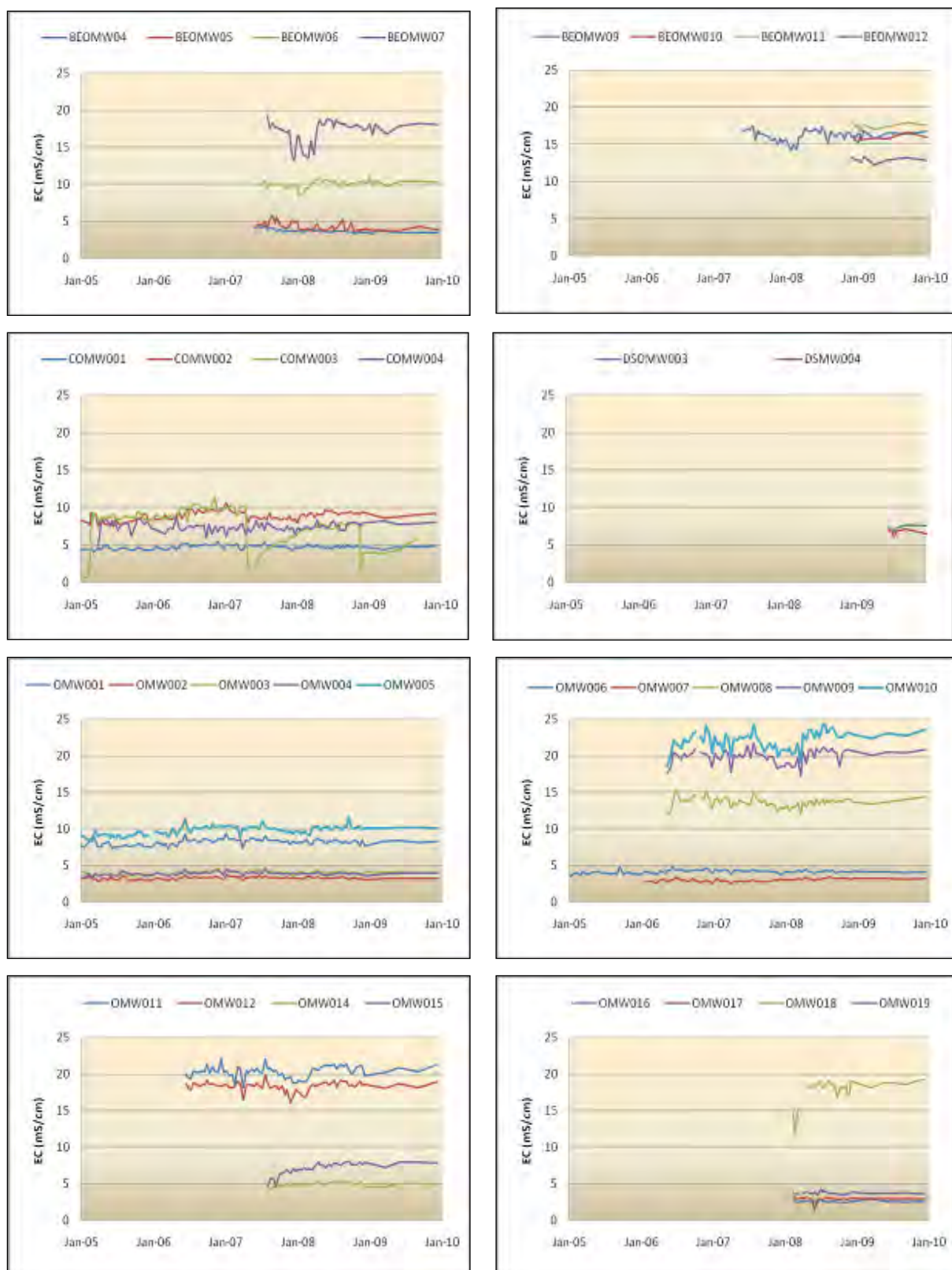
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Monitor Well Water Chemistry – Overlying



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Monitor Well Conductivity Graphs – Overlying



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APPENDIX F: Waste Disposal Pits Monitor Well Network Completion Report

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BEVERLEY MINE

Waste Disposal Pits Monitor Well Network Completion Report

December 2009

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4	Preliminary Monitoring	6
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1 INTRODUCTION

In 2004, the South Australian Environment Protection Authority (EPA) released its report “*Review of environmental impacts of the acid in-situ leach uranium mining process*” undertaken on its behalf by Commonwealth Scientific and Industrial Research Organisation (CSIRO) (CSIRO 2004). The review was in response to claims that acid in-situ leach (ISL) mining and disposal of waste would contaminate groundwater. It was a valuable opportunity for the EPA to re-examine the impacts of this mining process used in South Australia (EPA 2007).

The CSIRO review resulted in thirteen recommendations, the majority of which related to groundwater monitoring and the impact of natural attenuation processes on the presence of mining and disposal fluids. The South Australian Cabinet accepted the report and committed to fully implement the recommendations of the review.

In June 2007, the SA EPA released its report “*Review of environmental impacts of the acid in-situ leach uranium mining process – Implementation of recommendations*” (EPA 2007). The abstract of that report is reproduced below.

The recommendations from the Review of Environmental Impacts of the Acid In-situ Leach Uranium Mining Process (2004) have now been implemented into the appropriate regulatory programs of the South Australian Environment Protection Authority (EPA) and Department of Primary Industry and Resources, South Australia (PIRSA). Details of how the recommendations have been actioned are provided in the summary (see Page 8). Some outcomes from the recommendations require ongoing monitoring and assessment. Such requirements have also been included in the relevant monitoring programs. This report has been developed with the agreement from PIRSA and Department for Water, Land and Biodiversity Conservation (DWLBC).

This report has been prepared to demonstrate the fulfilment of the second part of Recommendation 6:

The number of monitor bores around the waste injection bore and waste disposal pits at Beverley should be examined to confirm whether the present number is considered to be adequate, with three additional Willawortina Formation wells around the Beverley waste disposal site recommended.

The first part of the recommendation regarding monitoring around the waste injection bore[s] has been addressed in Bev-Report.068 “Procedure for Management of Liquid Waste Disposal” dated October 2007 (Heathgate Resources 2007).

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2 HYDROGEOLOGICAL SETTING AND WELL DESIGN RATIONALE

The hydrogeology in the vicinity of the Beverley Mine consists of three main aquifers:

- Willawortina Formation (surface to ~95 m below ground level (bgl))
- Beverley Sands in the Namba Formation (105 – 140 m bgl)
- Great Artesian Basin (GAB) – Cadna-Owie Formation (330 – 380 m bgl).

The Willawortina Formation comprises a number of thin aquifers of low water yield, separated by clay layers. Where water is present, the quality is suitable for general stock use. At Beverley, pumping tests associated with trials indicate there is no connection with the Namba Formation aquifer.

The likelihood of leakage from the waste disposal pits is low because of the following factors:

- The area is arid with low groundwater recharge
- The waste disposal pits are situated on a slight rise, such that surface water which occurs occasionally due to rare heavy rainfall, is shed from both the pits and their surrounds
- The soil profile is deep and with common clay
- The depth to the water table is over 60 m
- The waste disposal pits are completed with a clay cover, and in the case of the low-level radioactive waste disposal pits, an impervious layer of plastic is placed above the waste beneath the final clay cap.

Only the Willawortina Formation is potentially vulnerable to contamination by leakage from the waste pits at Beverley. Hydraulic gradients are low in the aquifer but flow is interpreted to be in a generally west-to-east direction reflecting local topography. As a result, three monitor wells have been located with one upgradient and two downgradient of the disposal pits (Figure 1). This measures the actual local water table location, gradient and groundwater flow direction.

Any potential leakage would first be encountered at the water table, therefore the monitor wells have been constructed with screens across the water table rather than across the first 'aquifer' layer.

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3 CONSTRUCTION DETAILS

Well locations are shown in Figure 3-1 whilst coordinates are shown in Table 3-1. Wells are completed in the Willawortina Formation. Screened intervals are designed to straddle the water table. Wells were drilled at 6.5 inch diameter and cased with 4 inch class 12 PVC casing. Screen materials are slotted PVC wrapped with 179 micron mesh to prevent entry of fines. Casing was pressure grouted from 2 m above the screened interval to the surface. Well Construction details and coordinates are shown in Table 3-1.

Table 3-1: Well Construction Details

Hole ID	Pre-Hole ID	East GDA94	North GDA94	RL	Drill Depth	Screen Interval
3369	DMW001	364148.84	6658438.74	85.82	84	64-76
3367	DMW002	364615.05	6658362.79	81.17	84	59-71
3391	DMW004	364541.29	6658155.34	81.45	78	59-71



Figure 3-1: Location of low level waste disposal pits monitor wells

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4 PRELIMINARY MONITORING

Screened intervals access predominately low permeability silty clay sediments, thus very low well yields are anticipated. Educt airlift sampling devices were installed and used to purge the wells periodically until the educt sampling devices were replaced by low flow bladder pumps to allow ongoing sampling. However, yields proved too low for this method and stainless steel bailers were adopted in 2009 to allow regular sampling. Initial analyses are given in Table 4-1 and preliminary water level data in Table 4-2.

Table 4-1: Monitor well water quality (25 July 2009 (Ultratrace) and 06 September 2009 (SGS))

Parameter	Unit	DMW001		DMW002		DMW004	
		25/07/09	06/09/09	25/07/09	06/09/09	25/07/09	06/09/09
Ra-226	Bq/L	4.86 +/- 0.47	0.751 +/- 0.123	0.844 +/- 0.133	0.478 +/- 0.079	2.01 +/- 0.23	0.967 +/- 0.146
pH	pH units	7.1	7.8	7.1	7.7	7.0	7.5
EC	mS/cm	17.3	1.8*	19.6	7.6*	26.2	5.9*
ALK	mg/L	380	390	220	220	180	310
Hardness	mg/L	2320	2400	2800	2900	4150	4300
CO3	mg/L	<20	<1	<20	<1	<20	<1
HCO₃ Alkalinity	mg/L	380	471	220	260	180	370
TDS	mg/L	11750	11000	13550	13000	17450	17000
TDS Calculated	mg/L	10400	1100*	11800	4600*	15700	3500*
NO₃	mg/L	<20	<0.2	<20	<0.2	<20	4.9
SO₄	mg/L	1460	1500	1950	2100	2490	2600
SiO₂	mg/L	24	33	30	27	30	30
Al	mg/L	<0.2	0.56	0.2	0.13	<0.2	0.5
As	mg/L	<0.1	<0.020	<0.1	<0.020	<0.1	<0.020
B	mg/L	3.9	4.7	4.3	4.9	4.2	5
Ba	mg/L	0.1	0.09	0.2	0.12	<0.1	0.05
Br	mg/L	10.9	7.2	12.5	8.4	16.6	11
Ca	mg/L	539	560	708	750	922	1000
Cd	mg/L	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01
Cl	mg/L	5260	5200	5980	6100	7940	7800
Co	mg/L	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01
Cr	mg/L	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01
Cu	mg/L	<0.1	0.031	<0.1	0.016	<0.1	<0.010
F	mg/L	2	1.4	2	1.3	1	1.1
Fe	mg/L	<0.1	0.41	0.3	0.1	<0.1	<0.02
Hg	ug/L	<5	<0.1	<5	<0.1	<5	0.1
K	mg/L	46	42	46	43	62	69
Mg	mg/L	234	240	246	260	443	440
Mn	mg/L	2.1	0.87	<0.1	0.26	<0.1	0.03
Mo	mg/L	0.07	0.02	0.06	0.02	0.05	0.02
Na	mg/L	3130	3600	3560	4000	4390	5000
Ni	mg/L	0.1	0.03	0.1	0.05	<0.1	0.02
Pb	mg/L	<0.5	<0.005	<0.5	<0.005	<0.5	<0.005
Se	mg/L	<0.5	<0.01	<0.5	0.01	<0.5	0.039
Sr	mg/L	10.4	11	12	13	17.8	19
V	mg/L	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01
Zn	mg/L	<0.1	0.029	0.1	<0.010	<0.1	0.039
U	mg/L	0.25	0.19	0.045	0.041	0.1	0.13

* considered suspect, not consistent with other data

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Table 4-2: Monitor well water levels measured 22/3/2008)

Hole ID	Pre-Hole ID	RL	Stick up (m)	DTW (m)	rSWL
3369	DMW001	85.82	0.7	70.71	15.81
3367	DMW002	81.17	0.7	66.94	14.93
3391	DMW004	81.45	0.5	66.39	15.56

Water quality is within typical ranges for the deeper, sandy lenses in the Willawortina Formation that are monitored as part of the Mining and Rehabilitation Program (MARF). With respect to salinity they are all over the 10,000 mg/L TDS guideline for cattle (with production loss) and sheep adaption, at the upper end of the range of average TDS values for the deeper Willawortina Formation wells. Trace element concentrations, including radionuclides, vary by a factor of up to 5 and DMW001 is above the uranium guideline for livestock of 0.2 mg/L, but less than the highest deeper Willawortina average uranium value (unaffected by mining) of 0.51 mg/L (OMW016).

Water levels are similar to those in nearby deeper Willawortina Formation monitor wells.

The values presented here will be compared with future measurements to assess any possible trends in water quality or level that might be mine related.

5 ACKNOWLEDGEMENTS AND BIBLIOGRAPHY

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APPENDIX G: Annual Fauna Monitoring Report

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BEVERLEY URANIUM MINE ANNUAL FAUNA MONITORING

Beverley Mine Site and Beverley Extension Site

8th October – 23rd October 2009



BEVERLY URANIUM MINE ANNUAL FAUNA MONITORING

8th October – 23rd October 2009

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Cover Photos: Top Left – Red Kangaroo (*Macropus rufus*), Top Right – Central Bearded Dragon (*Pogona vitticeps*), Bottom Left – Fat-tailed Dunnart (*Sminthopsis crassicaudata*) tracks, Bottom Right - Australian Kestrel (*Falco cenchroides*).

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Executive Summary

This document reports on an annual fauna survey conducted at Beverley Uranium Mine by Environmental and Biodiversity Services (EBS) for *Heathgate Resources Pty Ltd*. The project was undertaken from October 8th to 23rd 2009, and involved repeat surveys of previously used monitoring sites at Beverley Uranium Mine (BU and BEXT) and Control (CON). The survey methods and survey effort used at each site were consistent with previous years with pitfall, Elliott, and cage traps, being used to survey mammals and reptiles. For the first time, Funnel Traps were used at each site for reptiles and mist nets, harp traps and AnaBat detectors were used to target bats as per previous surveys. In addition to trapping, active searching during the day was performed at each site as well as spotlighting at various locations to locate mammals and reptiles. Targeted bird surveys were undertaken at all sites, involving two hour long surveys (one hour in the morning and one hour in the afternoon). Opportunistic sightings of all fauna were also recorded when travelling between survey sites.

This survey included 10 trapping sites within the BEXT and BU area (classed as 'impact' sites), and eight CON trapping sites at least five kilometres from mining activities (classed as 'control' sites). The four BEXT sites were set up in 2007, and the six BU sites were established in 1996 and reinstated to a standard method in 2007. Six 'control' sites were established in 2008, with a further two established during the current 2009 survey.

The 2009 survey of the Beverley Mine sites recorded ten mammal species and 64 individuals whilst the Control sites recorded ten mammal species and 41 individuals. The slight differences recorded are not significant. A similar diversity and abundance of mammals was recorded in 2008 and significantly less than that recorded in 2007. Very few rodents were recorded during the 2009 survey and the number of Dasyurids (predominantly Dunnarts) was lower in the current survey. Two Dusky Hopping Mice (*Notomys fuscus*) were caught in 2009, one at site BU12 and one at BEXT05. The Dusky Hopping Mouse is rated as nationally **Vulnerable** under the *EPBC Act 1999* and has been recorded at Beverley since 2007.

A total of seven bat species recorded on the Anabat detectors in 2009 and all species have been previously recorded in the area. At the BU sites (where datasets extend back to 1996), the relative abundance and relative diversity of ground-dwelling mammal species was similar in 2009 and 2008. There was a strong correlation between rainfall and the relative abundance and relative diversity of ground-dwelling fauna. This indicates that the amount of rainfall received within a calendar year can have a substantial impact on the number and diversity of ground-dwelling mammals.

Sixteen reptile species and 55 individuals were recorded at the Beverley sites in 2009 whilst 14 species and 51 individuals were recorded at the Control sites. There was a significant

difference in reptile diversity at the Beverley sites when compared across the three years where the data collection has been consistent (2007 – 2009). The diversity and abundance of reptiles, when considering data from the Beverley and Control sites, was higher at the Major Creekline sites compared to the Minor Drainage Line and Gibber sites. No amphibian species were recorded in 2009, primarily due to the dry survey conditions and the lack of pre-survey rainfall.

A higher relative abundance and relative diversity occurred for reptile species compared to 2008, however, it was lower than the majority of other years where the annual survey has been undertaken. The correlation between reptile abundance and diversity and rainfall is slightly positive but it does not appear to be all that strong based on the current data.

Three hundred and forty individual birds, representing 39 species, were recorded at the Beverley sites in the 2009. Thirty-five species and 229 individuals were recorded at the Control sites and overall the Major Creekline sites had a higher diversity and abundance of birds compared to other sites.

The relative abundance and relative diversity of bird species in 2009 was slightly higher than 2008. The 2008 survey had the lowest abundance and diversity of all surveys with 2004 having the highest. There was a strong correlation between rainfall and abundance and diversity of birds with a higher diversity and abundance recorded when higher rainfall is recorded in the 12 months preceding the survey.

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1.0 Introduction

Environmental and Biodiversity Services (EBS) were contracted by *Heathgate Resources Pty Ltd* (Heathgate) to conduct the annual fauna monitoring survey within the Beverley Uranium Mine area on the North Olary Plains in South Australia. The survey forms a long-term fauna monitoring program to monitor the potential impact of the mine construction and operation on local fauna populations.

The field survey was undertaken between the 8th and 23rd of October 2009 at 18 monitoring sites, including six “BU” sites within the original Beverley Uranium Mine area (former Mining Lease ML 6036 and surrounds), four “BEXT” sites in the Beverley Uranium Mine Extension area (associated with new areas of the current Mining Lease ML 6321, which also subsumed ML 6036) and eight “CON” sites located approximately 5km from the proposed mining disturbance. Annual fauna surveys have been conducted at the Beverley Uranium Mine since the installation of permanent fauna trapping sites in 1996 (Gunninah Environmental Consultants 1997), whilst annual fauna surveys have recently commenced within the Beverley Extension area (baseline survey undertaken in 2006, annual survey commenced in 2007). Permanent fauna monitoring sites were re-established within the BU and BEXT (Beverley sites) area in 2007 to standardise the trap sites and trap effort at each site (EBS 2007a). A total of six ‘control’ sites were established in 2008 with an additional two ‘control’ sites established as part of the current survey. These sites are subsequently referred to as the Control sites. The Control sites provide a means of identifying any impacts that mining operations may have on the local fauna populations within the mining area.

To ensure that trapping effort and methods are consistent at all trapping sites across the Control sites, (original) Beverley Mine, Beverley Expansion area and the proposed Beverley Four Mile Project mine area, the sites were installed and trapping conducted in accordance with the South Australian Department for Environment and Heritage (SA DEH) vertebrate survey guidelines (as per Owens 2000). It is imperative that this methodology and trapping effort are maintained in future survey years, to enable accurate examinations of fluctuations in faunal assemblages among years. It is likely that several years (3-5) of survey data coupled with a comparison of rainfall data will be required before any potential changes could be confidently detected.

1.1 Survey Objectives

The objectives of the October 2009 survey are to continue to monitor the permanent fauna survey sites between the Beverley and Control sites, by:

- Following repeatable survey methods allowing for replication and statistical analysis over time through monitoring each site via:
 - Trapping small-medium mammals (including bats), reptiles, and amphibians;

- conducting bird surveys;
 - actively searching
 - and recording opportunistic observations of all fauna sighted;
- Establishing two new Control sites (CON07 and CON08) to allow better comparisons of results to be undertaken;
- Continuing to conduct on-foot and by car spotlight surveys
- Producing a document detailing the findings of the annual fauna survey for the Beverly sites and Control sites; and
- Providing recommendations in relation to fauna management in the area.

1.2 Regional context

Beverley Uranium Mine is located approximately 600 km north of Adelaide in the Flinders and Olary subregions of the Flinders Lofty Block Bioregion (Neagle 2003) in the South Australian rangelands on the North Olary Plains. These subregions are characterised by a chain of mountains and hills extending into arid gibber plains in the north and east (where the Beverley Uranium Mine is located). Characteristic habitat types of this region have been described by Neagle (2003) and Brandle (2001).

The survey sites within the Beverley Uranium Mine and Beverly Extension area (sites with a prefix BU and BEXT respectively) and the associated Control sites (sites with a prefix CON) are located within the following habitats:

- **Tall Shrubland adjacent a minor creekline** with Dead Finish (*Acacia tetragonophylla*), Elegant Wattle (*A. victoriae*), Emu-bush (*Eremophila* spp.), and Senna (*Senna* spp).
 - **BU11**
 - **BU16**
 - **BEXT05**
 - **BEXT04**
 - **CON01**
 - **CON04**
- **Major Ephemeral Creek Line (Four Mile Creek)** associated with Inland Paper-bark (*Melaleuca glomerata*) thickets and River Red Gum (*Eucalyptus camaldulensis*) Woodlands.
 - **BU12**
 - **BU13**
 - **CON07**
 - **CON08**

- **Gibber Plain** with Saltbush (*Atriplex* spp.), Bindyi (*Scleroleana* spp.) and Bluebush (*Maireana* spp.) herbland and shrublands. Mitchell Grass (*Astrebla pectinata*) would be a dominant species in this habitat when climatic conditions are suitable.
 - **BU14**
 - **BU15**
 - **BEXT02**
 - **BEXT03**
 - **CON02**
 - **CON03**
 - **CON05**
 - **CON06**

The main land-uses in this bioregion include pastoralism and in particular cattle grazing. Several conservation reserves are present in the area, the largest of which include Flinders Ranges National Park, the Vulkathunha-Gammon Ranges National Park, Lake Frome Regional Reserve, Arkaroola Wilderness Sanctuary (a private reserve) and Nantawarrina Indigenous Protected Area. Other land-uses include mining, with the Leigh Creek coal fields and Beverley Uranium Mine both operating in the region (Neagle 2003).

1.3 Climate

The arid zone tends to experience erratic rainfall, which rarely follows predictable annual patterns and includes some of the driest regions in South Australia (South Australian Arid Lands NRM Board 2007). Most rainfall is generally experienced in the winter/autumn months, though substantial summer rainfall events can also occur (Table 1). Extremely low rainfall has been recorded at the Beverley weather station in 2009 (January to October) with only 22.4 mm of rain received to the end of October 2009 (Table 1). Table 1 indicates that the first 10 months of 2009 have the driest first 10 months of a year at the Beverley Mine site in the last 10 years. There was a large amount of rain, approximately 70.4mm, recorded in December 2008, but no follow up rains were received; the next sizable rain was 56mm in November 2009, after the field survey. Therefore, the influence of the large December 2008 rainfall event on the annual fauna survey may be minimal. Figure 1 indicates that no single month in 2009 had greater than 6mm of rain with the exception of the 56mm in November 2009.

Weather conditions during the 2009 survey were mild to hot with little rainfall recorded (approximately 2.4mm rainfall) (see Table 2). There was little vegetation ground cover present, particularly at the Gibber sites, due to the lack of preceding rainfall. It is considered that the temperatures, minimum and maximum, experienced during the annual fauna survey were ideal for reptile species to be active. This increases the chance of detecting different species as well as increasing the number of individuals detected. However, during the current

survey wind speeds of up to 63 km/hr were experienced. Wind speeds this high can have a negative influence on the activity levels of species and therefore the number of animals captured.

Table 1. Monthly and yearly rainfall records from 2000 – 2009 recorded at the Beverley Mine Site weather station (data supplied by Heathgate Resources).

Year	Rainfall per month (mm)												Total rainfall (mm)
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
2000	0	66.5	8.5	35.5	17.5	20	0	5	2.5	32.5	0	7.5	195.5
2001	0	15	12.5	0	0	42.5	2.5	0	2.5	30	0	2.5	107.5
2002	17.5	5	0	0	10	0	0	0	0	0	7.5	33.5	73.5
2003	0	37.5	0	11.5	0	3	9	25.5	2.5	13	10.5	0.5	113.0
2004	1.5	6	0	0	8	17	0.3	9	44.5	0	6.5	9	101.75
2005	0	0	0	0	0	16	37	0.5	28.5	15.5	2	0	99.5
2006	14.5	7.5	2.5	14	0	2	32.5	0	0	2.5	4	1	80.5
2007	11.2	0	4.4	2.2	44.6	0	0	0.4	0	13	11.6	8.6	96.0
2008	1.6	5.4	1	0	0	23.8	0	3.8	1.4	0	13.1	70.4	120.5
2009	6.0	0	2.6	1.0	4.0	1.8	0.2	2.8	1.4	2.6	56.0	-	78.4*

*Year to date figure only, does not include December data

Table 2. Weather data obtained from the Beverley Uranium Mine weather station at 9.00am each day for the previous 24 hours for the duration of the Annual Fauna Survey (data supplied by Heathgate Resources).

Date	Min Temp °C	Max Temp °C	Ave Humidity %	Total Rainfall (mm)	Max Wind Speed (m/s)
8/10/2009	10.2	20.3	24.8	0	12.53
9/10/2009	12.9	22.4	21.3	0	8
10/10/2009	13.7	26.3	15	0	7.91
11/10/2009	19.9	32.2	16.7	0	14.89
12/10/2009	16	26.3	31.1	0.2	18.1
13/10/2009	11.5	24.4	35.8	0	17.63
14/10/2009	13.1	25.4	34.2	2.2	12.4
15/10/2009	9.8	23.2	35	0	15.61
16/10/2009	11.7	21	38.6	0	11.11
17/10/2009	11.5	21.9	35.3	0	10.27
18/10/2009	11.8	24	26.1	0	9.76

Date	Min Temp °C	Max Temp °C	Ave Humidity %	Total Rainfall (mm)	Max Wind Speed (m/s)
19/10/2009	16.4	29.7	14	0	7.37
20/10/2009	19.1	34.5	9.4	0	9.71
21/10/2009	21.3	36.8	11.5	0	9.64
22/10/2009	21.1	35.9	17	0	8.32
23/10/2009	21.4	34.7	16.5	0	9.25

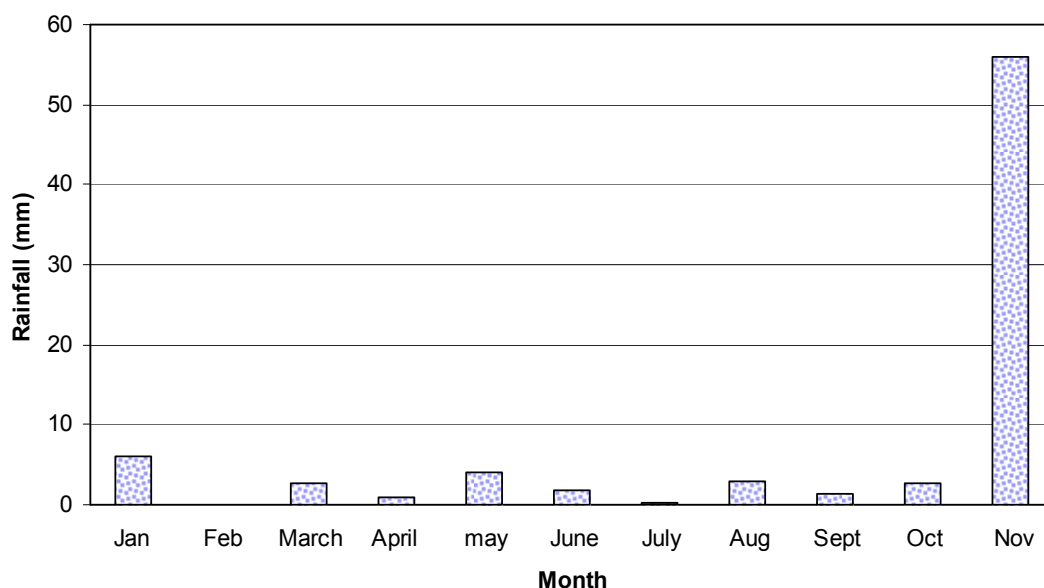


Figure 1. The monthly rainfall for 2009 up to the end of November recorded at the Beverley Uranium Mine Site weather station (data provided by Heathgate Resources).

1.4 Previous fauna surveys

Biological surveys involving mammal trapping conducted within the Beverley area as part of the existing Beverley Uranium Mine, Beverley Uranium Mine Expansion and the Beverley Four Mile Project include:

- *Beverley Uranium Project South Australia, Fauna Baseline Survey* (Gunninah Environmental Consultants 1997)
- *Beverley Uranium Mine Biological Monitoring* (Fatchen 2000, 2001 and 2002)
- *Beverley Uranium Mine Biological Monitoring, September-October 2003* (Tattersall 2003)
- *Beverley Uranium Mine Biological Monitoring, October-November 2004* (Carter 2004)
- *Biological Survey 2005 – Fauna 28 October to 3 November 2005* (Carter 2005)
- *Southern EL 3251 Fauna Survey* (EBS 2006a)
- *Beverley Uranium Mine Biological Survey 2006 – Fauna* (EBS 2006b)
- *Beverley Four Mile Project Baseline Fauna Survey* (EBS 2007b)
- *Beverley Uranium Mine Annual Fauna Monitoring* (EBS 2008a)

- *Beverley Four Mile Project Annual Fauna Survey* (EBS 2008b)

These biological surveys typically follow the standard methodology of pitfall, Elliott, and cage trapping, and recording opportunistic sightings of signs of animals (scats, diggings, tracks etc). Full details of this methodology are detailed in the *Guidelines for Vertebrate Surveys in South Australia* (Owens 2000).

Other known surveys in the region include:

- *A Biological Survey of the Flinders Ranges South Australia* (Brandle 2001)
- *An Inventory of the Biological Resources of the Rangelands of South Australia* (Neagle 2003)

As a result of the amount of survey effort, extensive datasets, of fauna species known to occur in different habitats within the area exist. Therefore, detailed knowledge of the species likely to occur within the Beverley sites are known and can be utilised when assessing possible impacts on fauna species, particularly those of conservation significance.

2.0 Methods

2.1 General

The baseline fauna survey for the Beverley Mine Project area was undertaken between the 8th and the 23rd of October 2009. A number of survey techniques were used to ensure a comprehensive coverage of species that occur in the survey area (detailed below). A total of 10 sites were utilised within the original Beverley Uranium Mine and Beverley Extension areas as well as eight Control sites located approximately 5km from mining activities.

The trapping and fauna detection methods used were based on the standard biological survey methodology developed by the South Australian Department for Environment and Heritage (refer to Owens 2000). Two pitfall lines, consisting of six pits per line (line A and line B) were installed at each fauna site, along with 30 Elliott traps, four funnel traps and four cage traps. Traps were checked for fauna in the morning and late afternoon of each day and bait was replaced if necessary. Each site was opened for a total of four nights.

Active searching, bird surveys (one hour in the morning and one hour in the afternoon) and AnaBat detectors were also used to detect fauna species at each of the trapping sites. In addition, harp traps and mist nets were used at some survey sites, as well as at a number of other suitable sites within the project area. All opportunistic sightings of fauna and their locations were recorded.

Annual monitoring was conducted under the following licences and permits:

- Scientific Research Permit No. M25542-3 (Department for Environment and Heritage)
- Wildlife Ethics Committee Permit No. 10/2008-M1 (Wildlife Ethics Committee)
- Scientific Licence No. 158 (Animal Welfare, National Parks and Wildlife SA)

2.2 Survey techniques

Pitfall traps

Six pitfalls were installed at each trap-line. Pitfalls consisted of PVC piping with a 150mm diameter and 400mm depth. Square pieces of metal mesh were attached to the bottom of each trap to act as the base and allow for water drainage during rainfall events. A 60m length of drift-net fence (metal mesh approximately 300mm high) was placed over the centre of each trap, connecting the traps.

Elliott traps

Elliott traps are small aluminium traps approximately 330mm long, 100mm high and 90mm wide. Each Elliott trap-line consisted of 15 traps spaced at approximately 10m apart. These

lines were installed approximately 30m from and parallel with the pitfall trap-lines. A small bolus of peanut butter, rolled oats and linseed oil was placed in all Elliott traps as bait. Elliott traps were normally left open day and night. In extreme weather conditions or if there was little cover for the traps, Elliotts were closed during the day.

Cage traps

Four cage traps were set at each site. Cage traps were placed approximately 10 m from either end of each pitfall trap line. Cage traps were baited with the same mixture used for Elliott traps and left open day and night. The cage traps were also closed during the day in extreme weather conditions.

Funnel Traps (new for 2009)

Funnel traps were used for the Beverley fauna surveys for the first time in 2009. Each trap site had four funnel traps (WA Poultry, Sheffield, Western Australia; 77 cm long, 17 cm wide, 17 cm high) (Figure 2) with one placed at each end of the pitfall line alongside the drift fences, and approximately 3 m from the end of the drift fence. Funnel traps were not baited to avoid damage caused by any captured House Mice.



Figure 2: Funnel traps placed either end of the drift fence.

Invertebrate Sampling

Invertebrates were sampled at each of the fauna trapping sites. This was undertaken by installing small vials (micro-pits), adjacent to the pitfall traps, which were full of an ethanol solution. Additionally, any larger invertebrates caught in the pitfall traps were placed in a separate jar of ethanol solution and kept. All invertebrates were taken to the SA Museum for identification with no data presented within this fauna report. The invertebrate sampling is not a regulatory requirement.

AnaBat Detectors

An AnaBat detector was used once at each of the trapping sites, with the AnaBat detector recording bat calls from early evening until early the following morning. Sites CON03, CON04

and CON06 were surveyed using the Anabat Detectors, however, there was a malfunction with the detectors and no data was recorded.

The identification of calls from bats is a difficult process and a number of bats have very similar calls. Therefore, some calls will be very similar and may not be able to be distinguished between species at all or at a reduced confidence level. Therefore, Anabat recordings are categorized into confident and probable based on the confidence in the identification of the call (generally based on the clarity, duration, frequency range and pattern of the calls). Due to the nature of the Anabat Detectors, only presence/absence data can be used as the abundance of bats is not necessarily correlated to the number of calls recorded.

Bird survey

Bird species diversity and abundance was assessed at all trapping sites. Surveys at the trapping sites consisted of a combination of slow walking and occasional stopping. All species seen or heard during these surveys were recorded. Sites were surveyed for a total of two hours, for one hour in the morning and one hour in the afternoon. Opportunistic observations of bird species were also noted.

Harp net trapping

A harp net trap was erected at several locations within the Beverley and Control sites. The trap was positioned in a possible bat fly-way between trees. The harp net was not used at all the monitoring sites due to the lack of potential fly-ways. The harp net was checked at night (approximately 9 – 10 pm) and in the morning (approximately 6 am).

Mist netting

A single mist net (15 m wide, approximately 7 m high) was erected for approximately 1.5 hours at North Mulga Dam. The net was erected and held in position along the edge of the water in the dam.

Active searching

Active searching (during the day) was used as an additional method to locate fauna (particularly reptiles) by actively looking underneath shrubs, in holes and under leaf litter. A minimum of 1 hour was spent actively searching each site.

Spotlighting

Spotlighting, both on foot (with handheld spotlights) and from the car, was undertaken. The spotlighting was undertaken at several locations within the project area. All species detected were recorded. Spotlighting was undertaken in the first two hours after sunset.

Opportunistic observations

Opportunistic observations are classified as chance sightings of animals, which are not premeditated through trap captures or active searching. Opportunistic observations of all fauna observed in the survey area were noted and their location recorded with a GPS unit.

Specimen identification and nomenclature

Each animal caught in a trap or observed when actively searching was, where possible, identified at the point of capture. If the animal could be identified to species level it was marked and released immediately. Any species where identification could not be determined immediately were kept overnight to allow correct identification. Animals kept overnight were released at the point of capture at an appropriate time for that species. As a requirement of the survey's Scientific Permit, voucher specimens were taken for any fauna species which have not been previously vouchered in the project area or where identification could not be confirmed. For those animals which were euthanized, a liver sample was taken and the carcass placed in formalin (for mammals) or setting trays (reptiles). At the end of the field survey, voucher specimens were taken to the South Australian Museum to confirm identification and to provide the museum with valuable biological data. No animals were vouchered during the 2009 fauna survey.

All captured animals were, where possible, identified at the point of capture, marked (see below) and released immediately at the point of capture or amongst nearby vegetation cover or burrows to reduce stress. Species nomenclature for scientific names and common names follows the *Vertebrates of South Australia* (Robertson *et al.* 2000) using commonly accepted local names.

Recapture markings

Captured mammals and reptiles were temporarily marked with a marker pen mark along the tail to distinguish first and subsequent recapture of individuals and aid understanding of approximate population estimates. Each captured individual was checked for the presence of previous marker pen markings, and if present were recorded as a 'recapture'.

Scats, tracks and other traces

Species which were not either caught or sighted but recorded through scats, tracks or diggings, were, where observed, counted as a single individual as the abundance cannot be estimated from these signs and traces.

Feral species removal

Captured feral pest animals such as the House Mouse and Cat were euthanized either immediately at the point of capture or taken to be euthanized by Heathgate staff.

3.0 Results

3.1 Site descriptions

The ten fauna sites at Beverley Mine site consisted of three main habitat types which are described in Table 3. The eight Control sites represent the dominant vegetation types in the area, and are located at least 5km from mining activities and consist of similar vegetation structure and habitat quality as the sites within the Beverley Mine area (Table 3). Figure 3 shows the locations of each trapping site for the Beverley and Control sites. Photos of each survey site are provided in Appendix 1.

The dominant landform within the survey area is the gibber plains which are dominated by a *Sclerolaena* spp. Low Open Herbland. Four Mile Creek passes through the Beverley Mine site and is a large ephemeral creek dominated by Red Gums (*Eucalyptus camaldulensis*) and Inland Paperbark (*Melaleuca glomerata*). Four Mile Creek is generally a sandy creekline, however, large areas of river stone are present. Numerous minor drainage lines join into the Four Mile Creek. The minor drainage lines are mixed in their composition with several containing low open chenopod shrublands and others containing Dead Finish (*Acacia tetragonophylla*) low shrublands. The minor drainage lines and associated vegetation are generally narrow (<50m) and the shrubs within the minor drainage lines can be quite patchy in distribution.

Table 3. Site descriptions, locations and associated habitat at each trapping site at the BU, BEXT and Control sites.

Site Name	Trap line	Zone	Easting	Northing	Landform	Habitat
BU11	A	54 J	365394	6660253	Minor Drainage Line	<i>Eremophila</i> spp. / <i>Acacia</i> spp. / <i>Santalum lanceolatum</i> Tall Shrubland alongside a minor drainage line
	B	54 J	365526	6660131		
BU12	A	54 J	365305	6661027	Major Drainage Line	Major drainage line dominated with <i>Eucalyptus camaldulensis</i> and <i>Melaleuca glomerata</i> thickets
	B	54 J	365431	6661060		
BU13	A	54 J	363297	6660554	Major Drainage Line	Major drainage line dominated with <i>Eucalyptus camaldulensis</i> and <i>Melaleuca glomerata</i> thickets
	B	54 J	363207	6660510		
BU14	A	54 J	364945	6658189	Gibber Plain	<i>Sclerolaena</i> spp. Herbland on high and low gibber plains
	B	54 J	365059	6658197		
BU15	A	54 J	362341	6658906	Gibber Plain	<i>Sclerolaena</i> spp. Herbland on high and low gibber plains
	B	54 J	362558	6658829		
BU16	A	54 J	364539	6657019	Minor Drainage Line	<i>Eremophila</i> spp. / <i>Acacia</i> spp. / <i>Santalum lanceolatum</i> Tall Shrubland alongside a minor drainage line
	B	54 J	364424	6657117		
BEXT02	A	54 J	364216	6655956	Gibber Plain	<i>Sclerolaena</i> spp. Herbland on high and low gibber plains
	B	54 J	364179	6655954		

Site Name	Trap line	Zone	Easting	Northing	Landform	Habitat
BEXT03	A	54 J	367656	6655808	Gibber Plain	<i>Sclerolaena</i> spp. Herbland on high and low gibber plains
	B	54 J	367623	6655822		
BEXT04	A	54 J	364842	6655500	Minor Drainage Line	<i>Eremophila</i> spp. / <i>Acacia</i> spp. / <i>Santalum lanceolatum</i> Tall Shrubland along a minor drainage line
	B	54 J	364792	6655545		
BEXT05	A	54 J	367123	6662048	Minor Drainage Line	<i>Eremophila</i> spp. / <i>Acacia</i> spp. / <i>Santalum lanceolatum</i> Tall Shrubland alongside a minor drainage line
	B	54 J	367056	6661989		
CON01	A	54 J	362406	6649607	Minor Drainage Line	<i>Acacia tetragonaphylla</i> Low Shrubland
	B	54 J	362476	6649558		
CON02	A	54 J	361421	6650746	Gibber Plain	<i>Sclerolaena</i> spp. Low Open Herbland
	B	54 J	361341	6650816		
CON03	A	54 J	372646	6657670	Gibber Plain	<i>Sclerolaena</i> spp. Low Open Herbland
	B	54 J	372571	6657557		
CON04	A	54 J	372276	6663822	Minor Drainage Line	<i>Acacia tetragonaphylla</i> Low Shrubland
	B	54 J	372157	6663810		
CON05	A	54 J	364671	6665482	Gibber Plain	<i>Sclerolaena</i> spp. Low Open Herbland
	B	54 J	364648	6665573		
CON06	A	54 J	356023	6658141	Gibber Plain	<i>Sclerolaena</i> spp. Low Open Herbland
	B	54 J	356086	6658035		
CON07	A	54 J	372090	6664661	Major Drainage Line	Major drainage line dominated with <i>Eucalyptus camaldulensis</i> and <i>Melaleuca glomerata</i> thickets
	B	54 J	372081	6664621		
CON08	A	54 J	355707	6658217	Major Drainage Line	Major drainage line dominated with <i>Eucalyptus camaldulensis</i> and <i>Melaleuca glomerata</i> thickets
	B	54 J	355634	6658195		

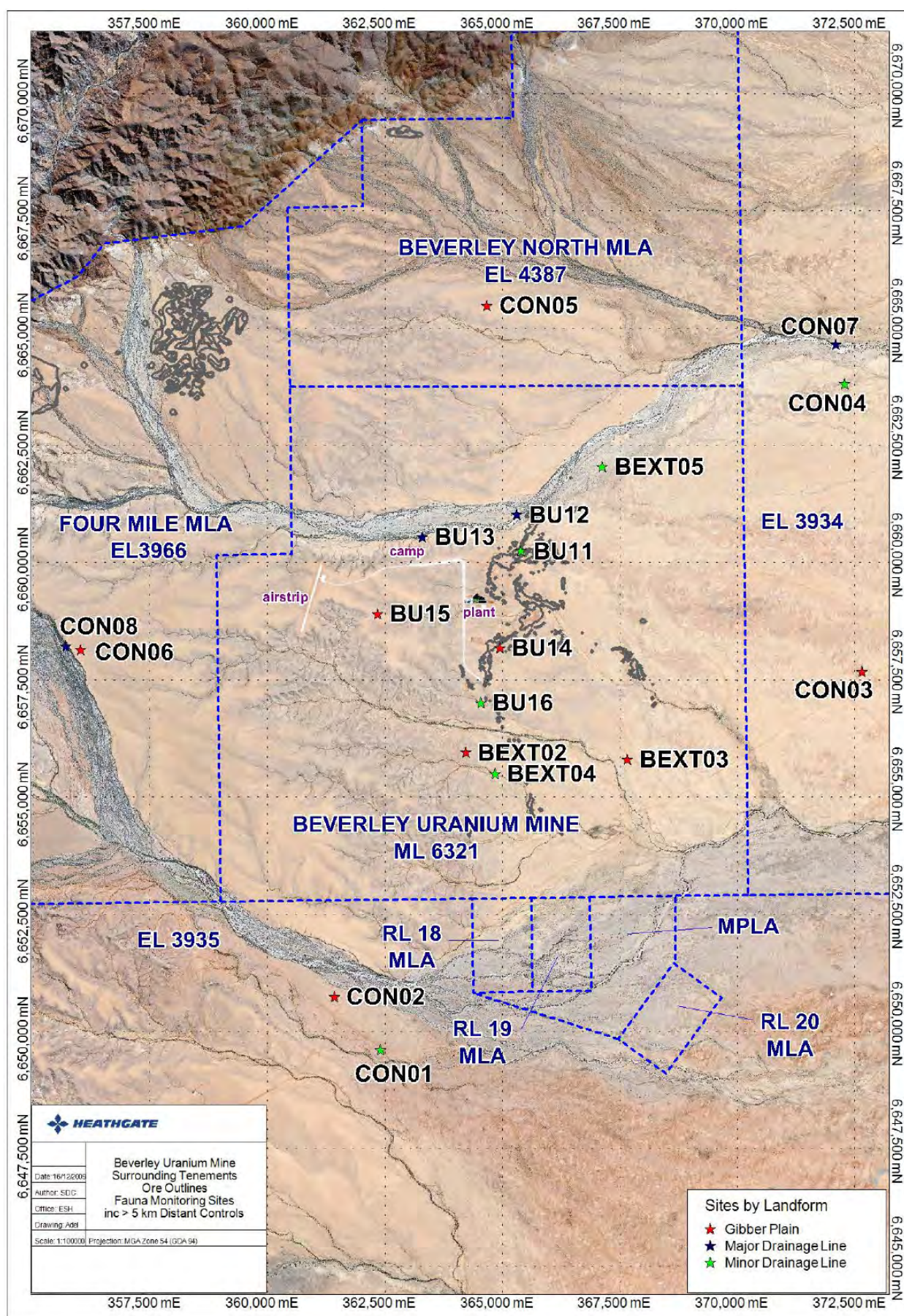


Figure 3. Location Beverley Mine, Four Mile and Control fauna survey sites, showing their proximity to mining operations

3.2 Trapping effort

Each trapping site was left open for four nights (Table 4). Spotlighting was undertaken at several sites when weather conditions permitted as well as along previous spotlight routes (Table 5). All sites were actively searched for reptiles during the day for a minimum of one hour. AnaBat detectors were placed at each trapping site for one night and each site was surveyed for birds for one hour in the morning and one hour in the afternoon. Mist netting was undertaken at North Mulga Dam, there was no water present in Four Mile Dam (Dingo Dam) and therefore no mist netting was undertaken at this location (Table 6). Harp Traps were utilised at several locations within the Four Mile, Control and Beverley Mine Sites (Table 6). An additional 45 Elliot traps were opportunistically set overnight at BU12 on the 21st of October to establish if Dusky Hopping Mice were still present in the area.

Table 4. Trapping effort for the October 2009 fauna survey at the Beverley Mine and Control Sites.

Site	Elliott trap		Pitfall traps		Cage traps		Day search hours	Bat detector nights	Bird survey hours
	Nights	Trap nights	Nights	Trap nights	Nights	Trap nights			
BU11	4	120	4	48	4	16	1	1	2
BU12	4	120	4	48	4	16	1	1	2
BU13	4	120	4	48	4	16	1	1	2
BU14	4	120	4	48	4	16	1	1	2
BU15	4	120	4	48	4	16	1	1	2
BU16	4	120	4	48	4	16	1	1	2
BEXT02	4	120	4	48	4	16	1	0	2
BEXT03	4	120	4	48	4	16	1	1	2
BEXT04	4	120	4	48	4	16	1	1	2
BEXT05	4	120	4	48	4	16	1	1	2
CON01	4	120	4	48	4	16	1	1	2
CON02	4	120	4	48	4	16	1	1	2
CON03	4	120	4	48	4	16	1	0	2
CON04	4	120	4	48	4	16	1	0	2
CON05	4	120	4	48	4	16	1	1	2
CON06	4	120	4	48	4	16	1	0	2
CON07	4	120	4	48	4	16	1	1	2
CON08	4	120	4	48	4	16	1	1	2
Total	72	2160	72	864	72	288	18	14	36

Table 5. Spotlighting effort for Four Mile, Control, and Beverley Mine sites, 2009.

Date	Location description	Easting	Northing	Hours	Spotlighting method
8/10/09	Main Camp to ED Camp	362962	6659870	.40	Car
		363842	6661349		
10/10/09	Round trip from Dingo Dam through Four Mile	358931	6661730	1	Car
11/10/09	Wetland near BU13	364059	6660610	1	Foot
		363744	6660585		
11/10/09	BU13 to BEXT05	363744	6660585	1	Car
		367736	6662821		
17/10/09	Open water tank	367880	6654368	.30	Foot
17/10/09	Open water tank to Main Camp	367880	6654368	1	Car
		362969	6659926		
19/10/09	Main Camp to North Mulga Dam	362969	6659926	.40	Car
		369675	6656673		
21/10/09	Four Mile Creek	358481	6661097	1	Foot
		358263	6661322		
Total Hours				6.1	

Table 6. Harp trap and mist net locations, 2009.

Date	Location Description	Easting	Northing	Number of Nights
Harp Trap				
10 & 11/10/09	BU12	365414	6661038	2
12/10/09	BU13	363301	6660541	1
13/10/09	FOU006	355166	6663845	1
14/10/09	Large creek near FOU008	358287	6661265	1
16 & 17/10/09	Open Water Tank	367884	6654369	2
18 & 19/10/09	CON07	372090	6664661	2
21 & 22/10/09	Main Camp	362986	6659982	2
Mist Netting				
19/10/09	North Mulga Dam	369675	6656673	1
Total Nights				12

3.3 Mammals

3.3.1 Beverley Mine Sites

Sixty-four mammals, representing ten species, were recorded at the Beverley ('BU') and Beverley Extension (BEXT) fauna sites (Table 7). Where a species was not recorded at a survey site, but scats, tracks or diggings were positively identified, they were counted as a single individual due to difficulties in determining abundance using these methods. The data collected for bat species from the AnaBat detectors has only been included in the discussions relating to species diversity and not species abundance. This is due to the AnaBat detectors only being able to detect the presence of a species and not the abundance of a species. The calls were put into two categories, confident and probable, based on the confidence in the identification of the calls.

The most abundant species were the Red Kangaroo (*Macropus rufus*) with twenty two individuals being observed and the Fat-tailed Dunnart (*Sminthopsis crassicaudata*) with seventeen individuals being caught (Table 7). Two Dusky Hopping Mice (*Notomys fuscus*) were caught, one at site BEXT05 and one at site BU12 (Figure 4). This species is listed nationally as **Vulnerable** (under the *Environment Protection and Biodiversity Conservation Act 1999*) and is also listed within South Australia as **Vulnerable** (under the *National Parks and Wildlife Act 1972*). The Dusky Hopping Mouse was caught at Beverley for the first time during the October 2007 fauna survey (EBS 2008a; Waudby and How 2008).

Of the "BU" monitoring sites, BU12, BU13 and BU15 had the highest mammal species diversity with three species detected (although one was the introduced Rabbit (*Oryctolagus cuniculus*)), and BU15 had the highest mammal abundance with fourteen individuals detected (Tables 7). Red Kangaroos were the most commonly detected species at the "BU" trapping sites with sixteen individuals observed (Table 7).

Of the "BEXT" monitoring sites, BEXT04 had the highest mammal abundance (nine individuals) and the equal highest mammal species diversity with four species detected, along with sites BEXT03 and BEXT05, which also had four species detected (Table 7). BEXT02 had the lowest mammal species diversity and abundance with only one species detected and observed (Tables 7). Fat-tailed Dunnarts and Red Kangaroos were the most commonly detected species at the "BEXT" trapping sites with six individuals of each caught or observed during the trapping period (Table 7).

The Echidna (*Tachyglossus aculeatus*) was recorded at three sites (BEXT04, BU12, and BU13), however this was from scats and tracks and therefore abundance could not be determined. Three exotic mammal species were recorded at the Beverley sites including Rabbits (*Oryctolagus cuniculus*), Feral Cat (*Felis catus*) (Figure 5) and Cow (*Bos taurus*) (Table 7).



Figure 4. Dusky Hopping Mouse (*Notomys fuscus*) caught at site BEXT05 in an Elliot trap



Figure 5. Feral Cat (*Felis catus*) caught at site BEXT05 in a cage trap

Three bat species were caught whilst mist netting at North Mulga Dam, including two Lesser Long-eared Bats (*Nyctophilus geoffroyi*), two Freetail Bats (*Mormopterus* sp3 or sp4) and one Inland Broad-nosed Bat (*Scotorepens balstoni*). Two bat species were caught at trapping sites including four Inland Freetail Bats (*Mormopterus* sp3) caught in a Harp Trap at BU13 and two Inland Forest Bats (*Vespadelus baverstocki*) caught in a Harp Trap at BU12.

A total of six bat species were recorded using the Anabat detector at the “BU” and “BEXT” trapping sites (Table 8). The Freetail Bat (*Mormopterus* sp3 or sp4) was the most common bat occurring at five of the ten Beverley sites, while the Inland Broad-nosed Bat (*Scotorepens balstoni*) was the least common occurring at one site (Table 8). Although the Freetail Bat (*Mormopterus* sp3 or sp4) was confidently identified at five trapping sites, the exact species cannot be determined from the calls alone.

The identification of calls from bats is a difficult process and a number of bats have very similar calls. Therefore, some calls are not distinguished between species at all or at a reduced confidence level. BEXT05 had the highest diversity of species with five bat species confidently identified at the site, whilst BU12 and BU15 recorded two bat species confidently. BEXT04, BU11, BU14 and BU16 did not get a confident or probable identification of a bat due to poor quality calls being recorded for these sites (Table 8). BEXT02 did not record any Anabat data due to malfunctioning equipment (Table 8).

An opportunistic Anabat was set up at North Mulga Dam in conjunction with mist netting. Seven bat species were recorded; all bat species had been previously recorded at the Beverley sites. Six bat species were confidently recorded, all as well as a probable Inland Broad-nosed Bat (*Scotorepens balstoni*). No abundance data can be determined from the Anabat detectors and therefore only presence / absence data were included.



Figure 6. Inland Freetail Bat (*Mormopterus* sp3) caught at site BU13 in a harp trap



Figure 7. Lesser Long-eared Bat (*Nyctophilus geoffroyi*) caught at North Mulga Dam whilst mist netting.

Table 7. Mammals detected during the October 2009 fauna survey at the Beverley Mine trapping sites.

Species Name	Common Name	BEXT02	BEXT03	BEXT04	BEXT05	BU11	BU12	BU13	BU14	BU15	BU16	TOTAL
<i>Bos taurus</i> *	Cow		Sc									1
<i>Felis catus</i> *	Feral Cat				1							1
<i>Macropus rufus</i>	Red Kangaroo	Sc	Sc	2	2+Sc+Sk	2+Sc+Tr		2	2	9+ Sc	Sk	22
<i>Mormopterus</i> sp 3	Inland Freetail Bat							4				4
<i>Notomys fuscus</i>	Dusky Hopping Mouse				1							1
<i>Oryctolagus cuniculus</i> *	Rabbit			5	2	Sc+Tr	2					10
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart		5	1					4	3	4	17
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart		1							2		3
<i>Tachyglossus aculeatus</i>	Echidna			Tr			Sc+Tr	Tr				3
<i>Vespadelus baverstocki</i>	Inland Forest Bat						2					2
Total observations for site		1	8	9	6	3	5	7	6	14	4	64
Total species for site		1	4	4	4	2	3	3	2	3	2	10

*Exotic species; Tr = track, species counted, abundance counted as 1; Sc = scat, species counted, abundance counted as 1; Sk = skeleton, species counted, abundance counted as 1.

Table 8. Bat species detected using the Anabat Detectors during the October 2009 fauna survey at the Beverley Mine trapping sites.

Species Name	Common Name	BEXT02	BEXT03	BEXT04	BEXT05	BU11	BU12	BU13	BU14	BU15	BU16	North Mulga Dam	Total
<i>Austronomus (Tadarida) australis</i>	White-striped Freetail Bat		x							x		x	3
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		x		x			x				x	4
<i>Chalinolobus morio</i>	Chocolate Wattled Bat											x	1
<i>Mormopterus</i> sp3 or sp4	Freetail Bat		x		x		x	x		x		x	6
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		x		x			x				x	4
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat				x							?	2
<i>Vespadelus baverstocki</i>	Inland Forest Bat				x		x	x				x	4
Total species for site		*	4	1**	5	1**	2	4	1**	2	1**	7	7

X = confident identification

? = probable identification

* = Equipment malfunction

1** = Total calls for the night consisted of small pulses which were to short or fragmented to confidently identify species, possibly due to equipment error.

3.3.2 Control Sites

Ten ground dwelling mammal species were detected at the Control trapping sites during the 2009 fauna survey with site CON01 having the highest diversity of species with six species being recorded (Table 9). Forty one individuals were recorded across the sites with CON08 having the highest abundance with nine individuals being recorded. CON02 had the lowest abundance and diversity of ground-dwelling mammal species with just one species identified and one scat recorded (Table 9). The domestic Cow was recorded by the presence of scats only at five of the Control sites. The scats were noted to be old and it is unclear as to when this species was last present.

The most common ground-dwelling mammal species was the Fat-tailed Dunnart (*Sminthopsis crassicaudata*) with twelve individuals recorded across the Control sites (Table 9). The least common species recorded were the Feral Cat (*Felis catus*), the Inland Freetail Bat (*Mormopterus* sp3) and the Stripe-faced Dunnart (*Sminthopsis macroura*) with only one individual or track of each species being recorded.

A total of three bat species were recorded using the Anabat detector at the Control trapping sites (Table 10). All three species were confidently identified at one or more trapping sites. The Southern Freetail Bat (*Mormopterus* sp3 or sp4) was identified from a total of four sites whilst the White-striped Freetail Bat (*Austronomus (Tadarida) australis*) and the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) was identified at two and three sites respectively (Table 10).

The identification of calls from bats can be difficult and a number of bats have very similar calls. Therefore, some calls will be very similar and may not be able to be distinguished between species at all or at a reduced confidence level. CON01 had the highest diversity of species with possibly three bat species identified, whilst CON02 and CON07 had one species identified (Table 10). No abundance data can be determined from the Anabat detectors and therefore only presence / absence data were included.

Table 9. Mammals detected during the October 2009 fauna survey at the Control trapping sites

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	Total
<i>Bos taurus</i> *	Cow	Sc	Sc	Sc	Sc	Sc				5
<i>Felis catus</i> *	Feral Cat	Tr								1
<i>Leggadina forresti</i>	Forrest's Mouse						1		1	2
<i>Macropus rufus</i>	Red Kangaroo	2		Sc	1+Sc	2+Sc+Tr		Tr		7
<i>Mormopterus</i> sp 3	Freetail Bat							1		1
<i>Mus musculus</i> *	House Mouse								3	3
<i>Oryctolagus cuniculus</i> *	Rabbit	2+Tr						1	5+Tr	8
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart	1		4		5	2			12
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart				1					1

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	Total
<i>Tachyglossus aculeatus</i>	Echidna	Tr								1
Total site observations		8	1	4	3	8	3	3	9	41
Total species for site		6	1	3	3	3	2	3	3	10

*Exotic species; Tr = track, species counted, abundance counted as 1; SC = scat, species counted, abundance counted as 1.

Table 10. Bat species detected using the Anabat Detectors during the October 2009 fauna survey at the Control trapping sites.

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	Total
<i>Austronomus (Tadarida) australis</i>	White-striped Freetail Bat	x				x				2
<i>Mormopterus</i> sp 3 or sp4	Freetail Bat	x	x			x			x	4
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	x						x	x	3
Total species for site		3	1	*	*	2	*	1	2	3

X = confident identification

? = probable identification

* Equipment malfunction

3.3.3 Comparison Between Beverley Mine and Control Trapping Sites

The overall diversity of mammal species between the Beverley Mine and Control sites was similar with ten species being recorded across both groups of sites. However, the Beverley sites recorded a higher abundance with 64 individuals recorded compared to the forty-one individuals recorded at the Control sites (Tables 7 & 9). There were no significant differences between the Beverley and Control sites for either mammal abundance (two-sample t-test for unequal variances, $t(14) = -0.38$, $p=0.35$) or mammal diversity (two-sample t-test for unequal variances, $t(14) = 0.15$, $p=0.44$). Species recorded at Beverley Mine and Control sites differed, as Forrest's Mouse (*Leggadina forresti*) and House Mouse (*Mus musculus*) were recorded only within the Control sites, while the Dusky Hopping Mouse (*Notomys fuscus*) and Inland Forest Bat (*Vespadelus baverstocki*) were recorded only within the Beverley sites (Table 7 and 9).

Rodents and Dasyurids (small mammals) are analysed separately from total mammals as these smaller mammals are the target size for pitfall traps and Elliot traps which make up the majority of our trapping effort. When comparing small mammal abundance to total mammal abundance, it can be seen that small mammals made up less than fifty percent of the total mammal abundance at seven of the ten Beverley sites (Figures 8 & 9). This is very similar findings to those made at the Control sites where small mammal abundance made up less than 50 percent of the total mammal abundance at five of the eight sites (Figures 8 & 9).

Figure 8 shows the sites grouped based on the habitat in which they occur. It can be seen that for similar habitats, there does not appear to be a clear trend between the Beverley Mine sites and Control sites. The low mammal abundance and species diversity recorded in the current survey makes it difficult to effectively identify any potential impacts of mining operations based on the current year's data only. This is because variability in the data may be a result of other factors such as trapping effectiveness, or weather conditions. The collection of subsequent years of data using the same trapping methods, and collecting weather data is of value as longer-term data sets may identify informative trends.

The diversity of bat species between the Beverley Mine and Control sites differed with six bat species being recorded using the Anabat Detectors at the Beverley Mine sites while three bat species were recorded at the Control sites (Tables 8 & 10). However, three of the Control sites had an equipment malfunction thereby reducing the number of sites successfully surveyed using this method (one Beverley site also experienced an equipment malfunction). When comparing bat diversity at similar habitats between Beverley Mine Sites and Control sites, it can be seen that within Gibber and Major Drainage Line habitat, the Beverley Mine Sites had on average three bat species per site while the Control sites had on average one and a half bat species per site (Figure 10). Within the Minor Drain habitat the Beverley Mine sites had on average five bat species per site while the Control sites had on average three bat species per site. This may suggest that the bat diversity is greater at the Beverley sites than the Control sites within all three habitat types, however, the number of replicates is not the same due to equipment malfunctions.

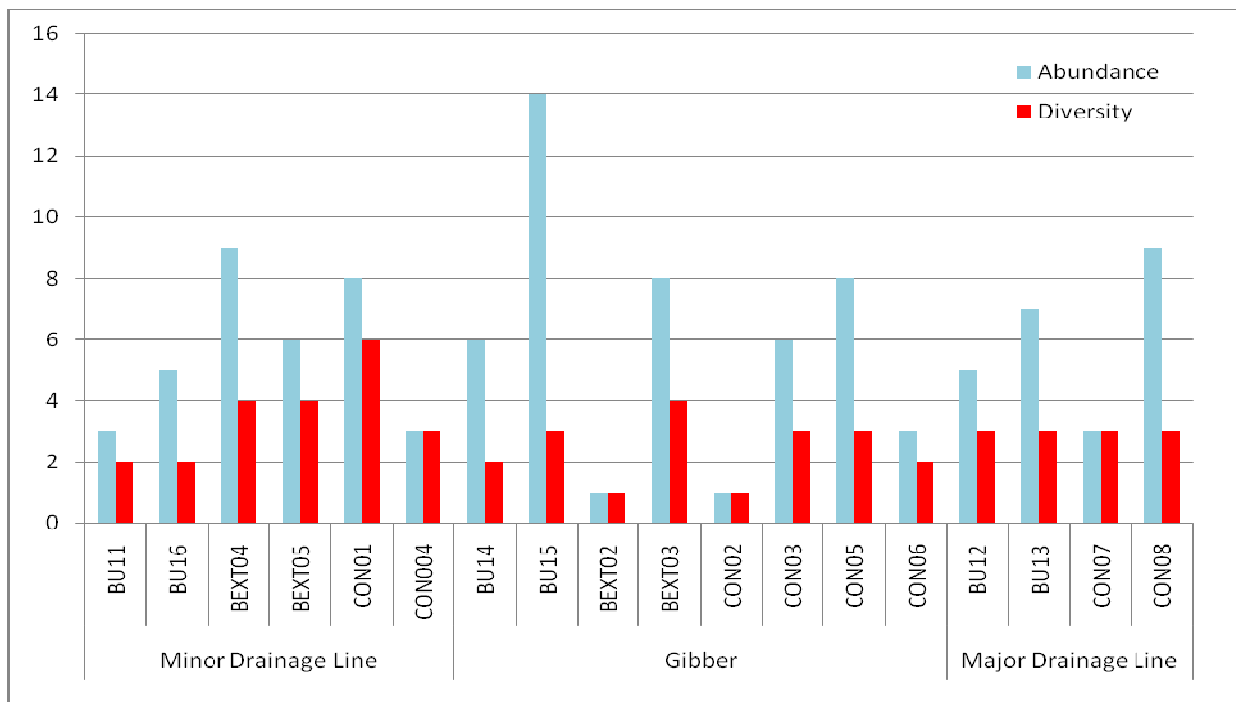


Figure 8. Comparison of mammal abundance and diversity between the Beverley Mine and Control sites for the 2009 fauna survey.

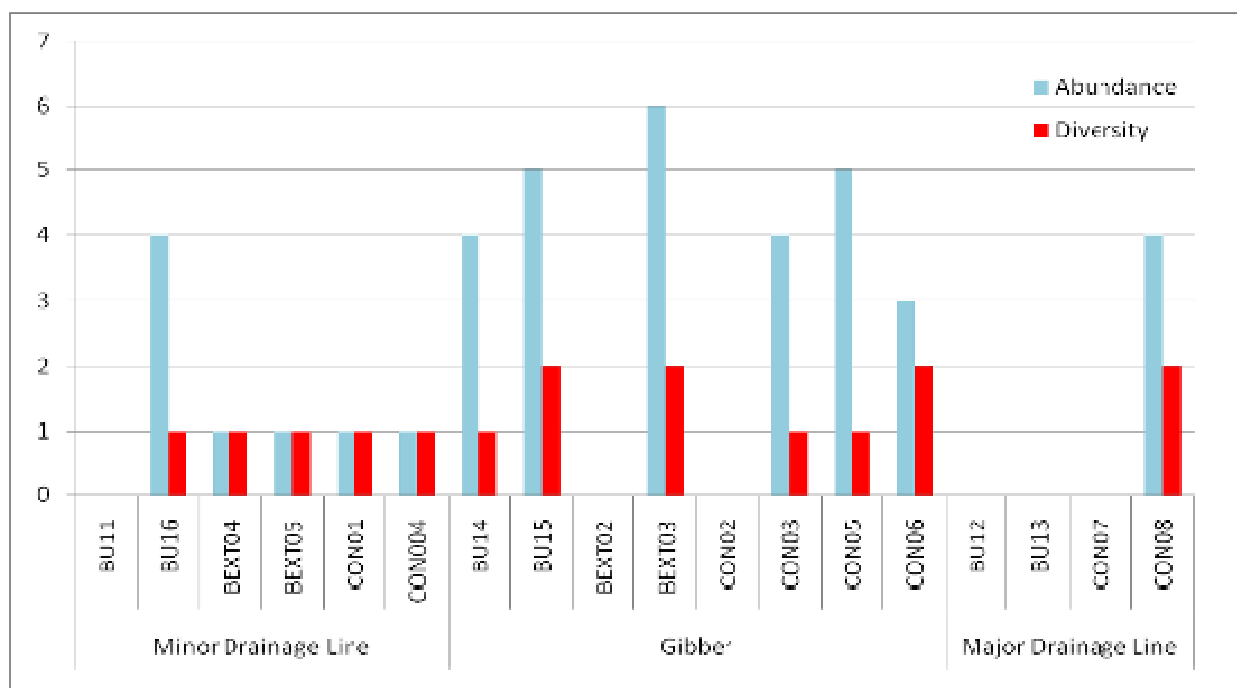


Figure 9. Comparison of small mammal abundance and diversity (Rodents and Dasyurids combined) between the Beverley Mine and Control sites for the 2009 fauna survey

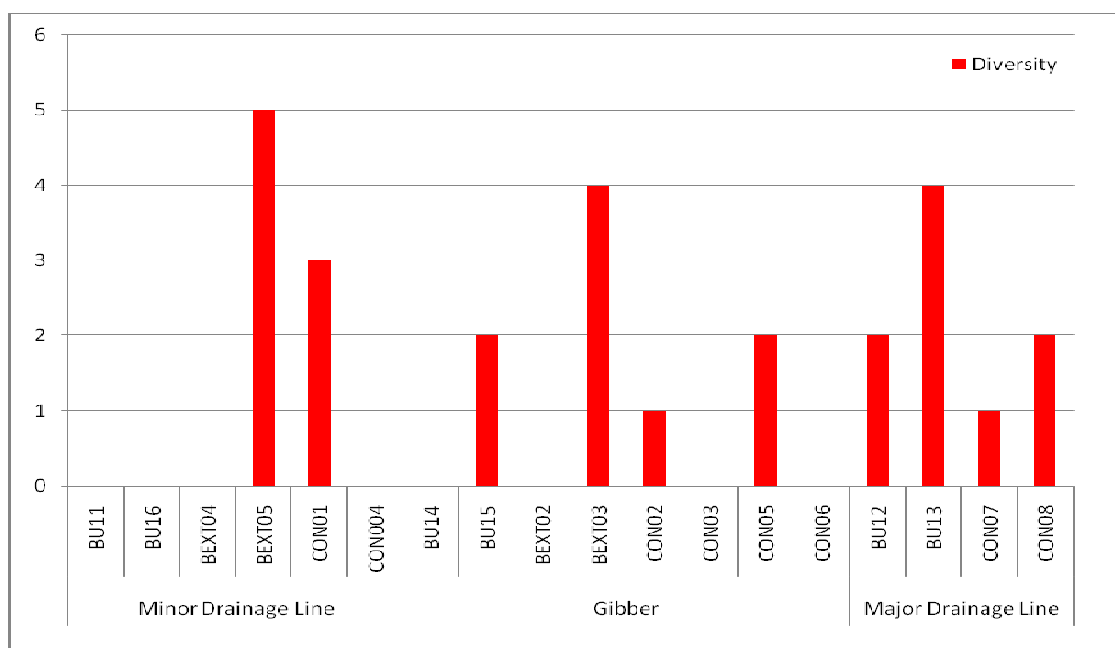


Figure 10. Comparison of bat diversity between the Beverley Mine and Control sites for the 2009 fauna survey

Note:

BEXT02, CON03, CON04, and CON06 did not record any results due to malfunctioning equipment. BU11 and BU14 recorded only small and fragmented calls which could not be identified as any particular bat species.

3.3.4 Comparison between 2007, 2008 and 2009 Results

Beverley Mine Sites

The data collected between 2007 and 2009 at the “BU” and “BEXT” sites can be compared directly as the survey methods have been consistent over this time. Of the three years, 2007 had the highest abundance and diversity of species with 15 mammal species and 155 observations being recorded (Figures 11 and 12). The lowest abundance and diversity was recorded during the 2009 survey with nine species and 60 observations recorded (Table 11). The differences recorded in mammal abundance and diversity between 2007 and 2009 was significant (ANOVA: $F(2,27) = 11.14$, $p < 0.001$ and $F(2,27) = 6.25$, $p < 0.01$, respectively).

Six species recorded in 2007 have not been recorded in the subsequent 2008 and 2009 surveys (Table 11). These included Sandy Inland Mouse (*Pseudomys hermannsburgensis*), Gould’s Wattled Bat (*Chalinolobus gouldii*), Dingo (*Canis lupis dingo*) and Lesser Long-eared Bat (*Nyctophilus geoffroyi*) (Table 11). All species recorded in 2009 have been previously recorded at the Beverley sites in either 2007 or 2008 or both years. The House Mouse (*Mus musculus*) was recorded in 2007 (25 individuals) and 2008 (nine individuals) but not in 2009 (Table 11).

Anabat results reveal that no new bat species were recorded in the current survey of 2009, and species diversity was lower compared to 2007. This was attributable to the absence of Finlayson's Cave Bat (*Vespadelus finlaysoni*) in the current survey (Table 12). The number of bat species recorded at the each site was generally lower in 2009 compared to other years (Table 12); however, the results may be influenced by no data being available for several sites (due to an equipment malfunction).

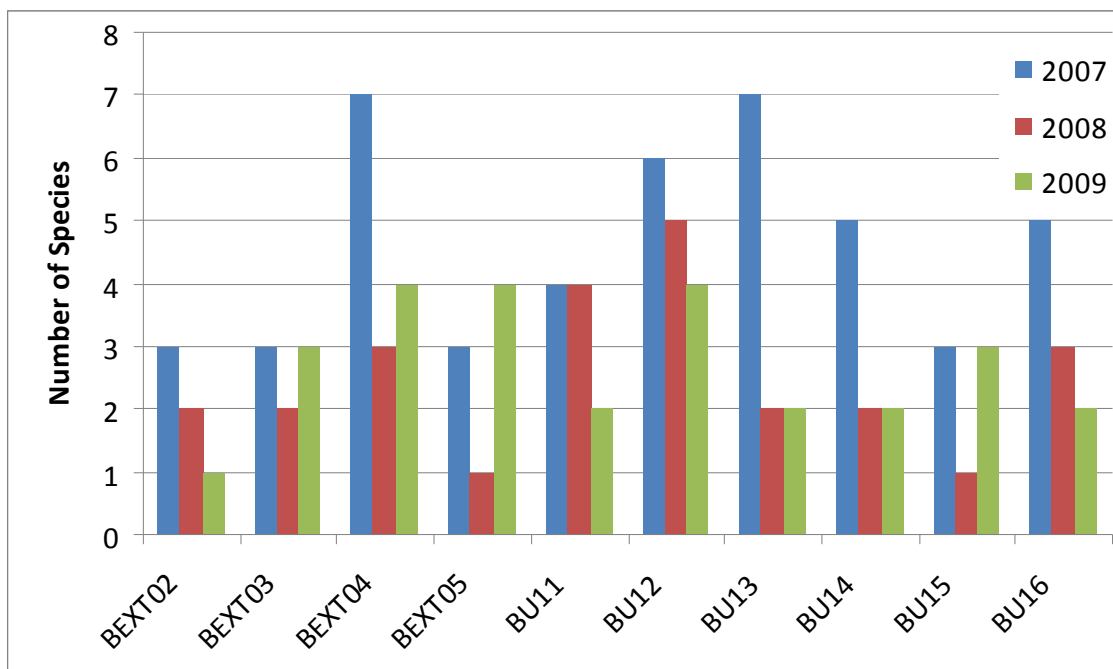


Figure 11. Species diversity for mammals across Beverley Mine Sites between 2007, 2008 and 2009

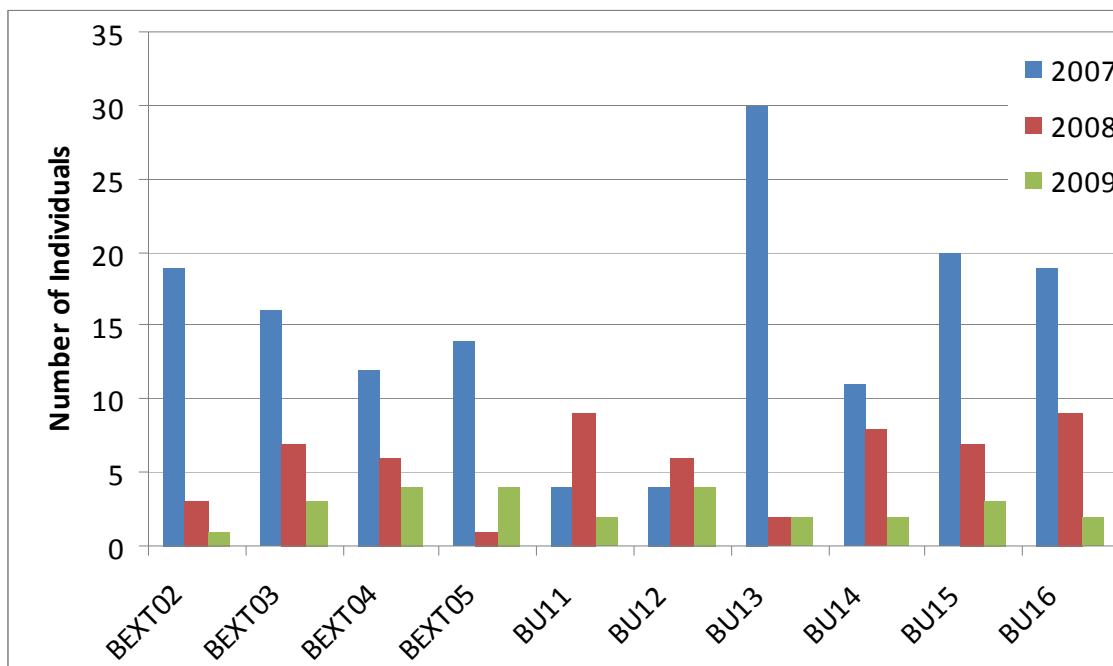


Figure 12. Species abundance for mammals across Beverley Mine Sites between 2007, 2008 and 2009

Table 11. Mammal species recorded at the Beverley trapping sites in annual fauna surveys between 2007, 2008 and 2009.

Species Name	Common Name	BEXT02			BEXT03			BEXT04			BEXT05			BU11			BU12		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Canis lupus dingo</i>	Dingo							1											
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat																		
<i>Bos taurus</i>	Cow						Sc		7										
<i>Felis catus</i>	Feral Cat							1					1					1	
<i>Leggadina forresti</i>	Forrest's Mouse		2		1														
<i>Macropus rufus</i>	Red Kangaroo	10		Sc		1	Sc		1	2			2+Sc+Sk		1	2+Sc+Tr			
<i>Mormopterus planiceps</i> (big penis)	Southern Freetail Bat																		
<i>Mormopterus</i> sp 3	Freetail Bat																		
<i>*Mus musculus</i>	House Mouse							3			11				2	6		1	
<i>Notomys fuscus</i>	Dusky Hopping Mouse										1		1				1	2	1
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat																1		
<i>*Nyctolagus cuniculus</i>	Rabbit									5			2		2	1	Sc+Tr	1	2
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse							1											
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat																1		
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart	5			10	6	5	4	3	1	2				1				
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart	4	1		5		1	1	2					2					
<i>Tachyglossus aculeatus</i>	Echidna							1		Tr		1		1			2	1	Sc+Tr
<i>Vespadelus baverstocki</i>	Inland Forest Bat																	1	2
Total observations for site		19	3	1	16	7	8	12	13	9	14	1	6	7	9	3	7	6	6
Total species for site		3	2	1	3	2	4	7	4	4	3	1	4	4	4	2	6	5	4

*Exotic species; Tr = track, species counted, abundance counted as 1; Sk = skeleton, species counted, abundance counted as 1; Sc = scat, species counted, abundance counted as 1.

Table 11 Continued

Species Name	Common Name	BU13			BU14			BU15			BU16			Total		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Canis lupus dingo</i>	Dingo													1	0	0
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	1												1	0	0
<i>Bos taurus</i>	Cow													0	7	1
<i>Felis catus</i>	Feral Cat													1	1	1
<i>Leggadina forresti</i>	Forrest's Mouse				1									2	2	0
<i>Macropus rufus</i>	Red Kangaroo			2	2		2	11		9+ Sc	3		Sk	26	3	22
<i>Mormopterus planiceps</i> (big penis)	Southern Freetail Bat	1												1	0	0
<i>Mormopterus</i> sp 3	Freetail Bat			4												
* <i>Mus musculus</i>	House Mouse	2			1	3		1			4			25	9	0
<i>Notomys fuscus</i>	Dusky Hopping Mouse													2	2	2
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	12									6			19	0	0
* <i>Oryctolagus cuniculus</i>	Rabbit		1									1		3	4	10
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse													1	0	0
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	10												11	0	0
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart				3	5	4	8	7	3	4	4	4	36	26	17
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart	3			4					2	2	4		21	7	3
<i>Tachyglossus aculeatus</i>	Echidna	1	1											5	3	2
<i>Vespadelus baverstocki</i>	Inland Forest Bat													0	1	2
Total observations for site		30	2	6	11	8	6	20	7	14	19	9	4	155	65	60
Total species for site		7	2	2	5	2	2	3	1	3	5	3	2	15	11	9

*Exotic species; Tr = track, species counted, abundance counted as 1; Sk = skeleton, species counted, abundance counted as 1; SC = scat, species counted, abundance counted as 1.

Table 12. Bat species recorded at the Beverley trapping sites in the 2007 and 2008 annual monitoring using AnaBat Detectors.

Species Name	Common Name	BEXT2			BEXT3			BEXT4			BEXT5			BU11			BU12		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Austronomus (Tadarida) australis</i>	White-striped Freetail Bat	X			X		X	X	X		X	X		X	X			X	
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat						X				X	?	X	X	?		?		
<i>Chalinolobus morio</i>	Chocolate Wattled Bat										?				?				
<i>Mormopterus</i> sp 3 or sp4	Freetail Bat	X			X		X	X			X	X		X	X		X	X	X
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat						X				X		X		X		X	X	
<i>Scotorepens balstoni</i> ?	Inland Broad-nosed Bat										?	?	X		?		X		
<i>Vespadelus baverstocki</i>	Inland Forest Bat										X		X	X	X		X		X
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat																		
Total species for site		2	0	*	2	0	4	2	1	**	7	4	5	4	7	**	3	5	2

X = confident identification of call; ? probable identification of call

* = Equipment malfunction

** = Total calls for the night consisted of small pulses which were to short or fragmented to confidently identify species, possibly due to equipment error.

Table 12 Continued

Species Name	Common Name	BU13			BU14			BU15			BU16			North Mulga Dam			Total		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Austronomus (Tadarida) australis</i>	White-striped Freetail Bat		X					X		X	X			X	X	X	8	7	3
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		?	X					?		X	?		X	X	X	4	7	4
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	X	?												X	X	2	3	1
<i>Mormopterus</i> sp 3 or sp4	Freetail Bat	X	X	X				X	X	X		X		X	X	X	9	7	6
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	?	X	X				X						X		X	5	3	4
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat		?						?			?			X	?	1	7	2
<i>Vespadelus baverstocki</i>	Inland Forest Bat		?	X										X	X	X	4	3	4
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat													X			1	0	0
Total species for site		3	7	4	0	1	**	3	3	2	2	3	**	6	6	7	8	7	7

X = confident identification of call; ? probable identification of call

** = Total calls for the night consisted of small pulses which were to short or fragmented to confidently identify species, possibly due to equipment error.

Control Sites

For the Control sites, only six sites were installed in 2008 whilst there were eight in 2009 (CON07 and CON08 were the additional sites). Overall, when comparing only the six control sites which have data for both years, 17 observations of five mammal species were recorded in 2008 at the Control sites compared to 26 observations of seven species in 2009 (Table 13). When all data is included, there is no significant difference in the abundance (ANOVA: $F(1,12) = 2.93$, $p = 0.11$) or diversity (ANOVA: $F(1,12) = 3.32$, $p = 0.09$) of mammal species between 2008 and 2009 for the Control sites.

There were two species that were recorded in 2008 that were not recorded in 2009, House Mouse (*Mus musculus*) and Sandy Inland Mouse (*Pseudomys hermannsburgensis*) (Table 13). Additionally, there were several species that were recorded in 2009 but were not recorded in 2008; they were Cow (*Bos Taurus*), Feral Cat (*Felis catus*), Red Kangaroo (*Macropus rufus*) and Rabbit (*Oryctolagus cuniculus*). A similar number of individuals of each species were observed for species recorded in both years (Table 13).

For sites CON02, CON03, CON04 and CON06 there was little difference between the abundance and diversity of mammal species between 2008 and 2009 (Figures 13 and 14). However, site CON01 recorded two species in 2008 compared to six in 2009 (Figure 13). A similar result was observed for the abundance at each site with CON01 recording two individuals in 2008 and eight in 2009 (Figure 14). CON05 had three more individuals recorded in 2009 compared to 2008, but the species diversity was the same in both years (Table 13).

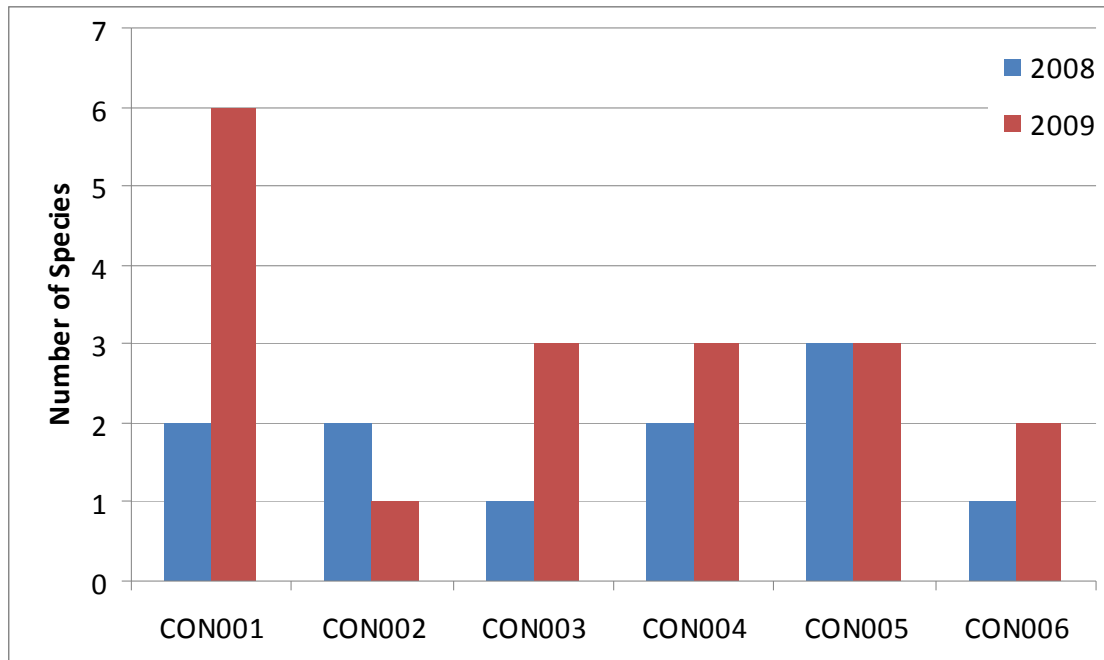


Figure 13. Species diversity for mammals across Control Sites for 2008 and 2009 where sites were surveyed in both years.

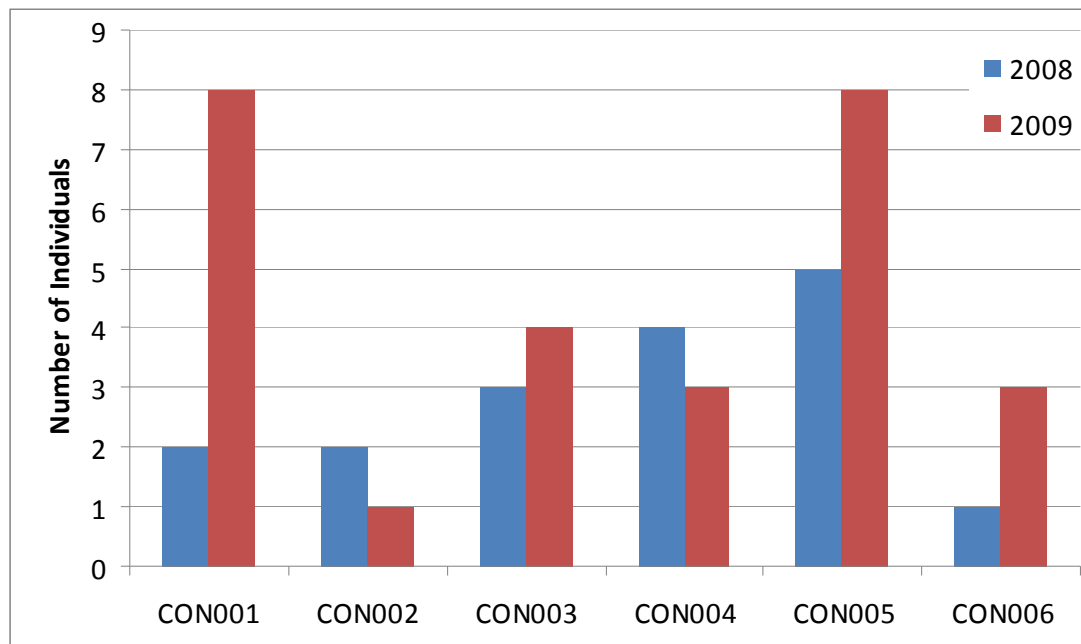


Figure 14. Abundance of mammals across Control sites for 2008 and 2009 where sites were surveyed in both years.

Table 13. Mammal species recorded at the Control trapping sites in the 2008 and 2009 fauna surveys.

Species Name	Common Name	CON001		CON002		CON003		CON004		CON005		CON006		CON007	CON008	Total	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2009	2008	2008	2009
<i>Bos taurus</i>	Cow		Sc		Sc		Sc		Sc		Sc					0	5
<i>Felis catus</i>	Feral Cat		Tr													0	1
<i>Leggadina forresti</i>	Forrest's Mouse									1			1		1	1	2
<i>Macropus rufus</i>	Red Kangaroo		2				Sc		1+Sc		2+Sc+Tr			Tr		0	7
<i>Mus musculus</i> *	House Mouse							2		1				1		3	1
<i>Oryctolagus cuniculus</i> *	Rabbit		2+Tr												3	0	5
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse			1										1	5+Tr	1	6
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart	1	1			3	4	2		3	5	1	2			10	12
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart	1		1					1							2	1
<i>Tachyglossus aculeatus</i>	Echidna		Tr													0	1
Total site observations		2	8	2	1	3	6	4	3	5	8	1	3	3	9	17	41
Total species for site		2	6	2	1	1	3	2	3	3	3	1	2	3	3	5	10

*Exotic species; Tr = track, species counted, abundance counted as 1; SC = scat, species counted, abundance counted as 1.

3.3.5 Comparison Between All Years for BU Trapping Sites

A comparison between the results of all years of the fauna monitoring has been undertaken for the “BU” sites as these are the only sites that currently have the longer term data collected. The main issue with analysing this data is inconsistent trapping efforts from year to year. However, the analysis undertaken converted the data to relative abundance and relative diversity of species which takes into account the trapping effort in any one year for the results achieved in that year. In 2000 and 2001, only trapping sites BU14 and BU15 were surveyed, both of these sites are within gibber habitat. These results have been left in the analysis, however, as only one of the three main habitat types was surveyed in these years and it is likely that this will influence the results of the analysis. Additionally, equipment malfunction will also cause inconsistencies in the data analysis.

The relative abundance and diversity was calculated by grouping the data from all six “BU” sites together and dividing it by trap effort to display data as the abundance and diversity within a year per 100 trap nights. For mammal data, only data collected from pitfall, Elliott and cage traps was used as the trap effort can be calculated. The only data used in this analysis is for ground dwelling mammals captured in traps; all opportunistic observations have been removed as the survey effort (and therefore relative abundance) cannot be determined for most years.

Figure 15 shows the relative abundance of mammal species at the “BU” trapping sites for all years where fauna surveys have been undertaken. The relative abundance of mammals has varied, with higher abundances observed in the 1996, 2000, 2001 and 2005 surveys. Figure 15 also shows that the relative abundance in 2009 is the lowest it has been since 2004.

The relative diversity of ground dwelling fauna captured at the “BU” sites has been quite consistent since 2002 (Figure 16). The relative diversity has declined slightly over the past two years indicating that less species are being recorded across the sites in these years. There appears to be less variation in the relative diversity between years when compared to the relative abundance which is primarily due to the moderately low number of ground dwelling mammal species occurring within the area. Interestingly the peak in the mammal diversity in 2000 and a smaller peak in 2005 correspond to a higher abundance recorded within those years (Figures 13 and 14).

Figure 15 shows the correlation between rainfall and the relative abundance for ground dwelling mammal species with all years included in the analysis except for 1996 and 2000 where no rainfall data was available. There is a positive correlation between rainfall and relative abundance of ground dwelling mammal species, with lower rainfall years resulting in a lower relative abundance (Figure 15). In one year (2003), more than 200mm of rainfall was

received; however, the relative abundance was lower than most years. It is possible that the rainfall was received either early or late in the year (timing of rainfall was not analysed) and therefore, may not have influenced ground dwelling mammal populations.

A similar correlation occurred for the relative diversity of ground dwelling mammals and rainfall where a higher diversity is recorded in years where the annual rainfall was higher (Figure 18).

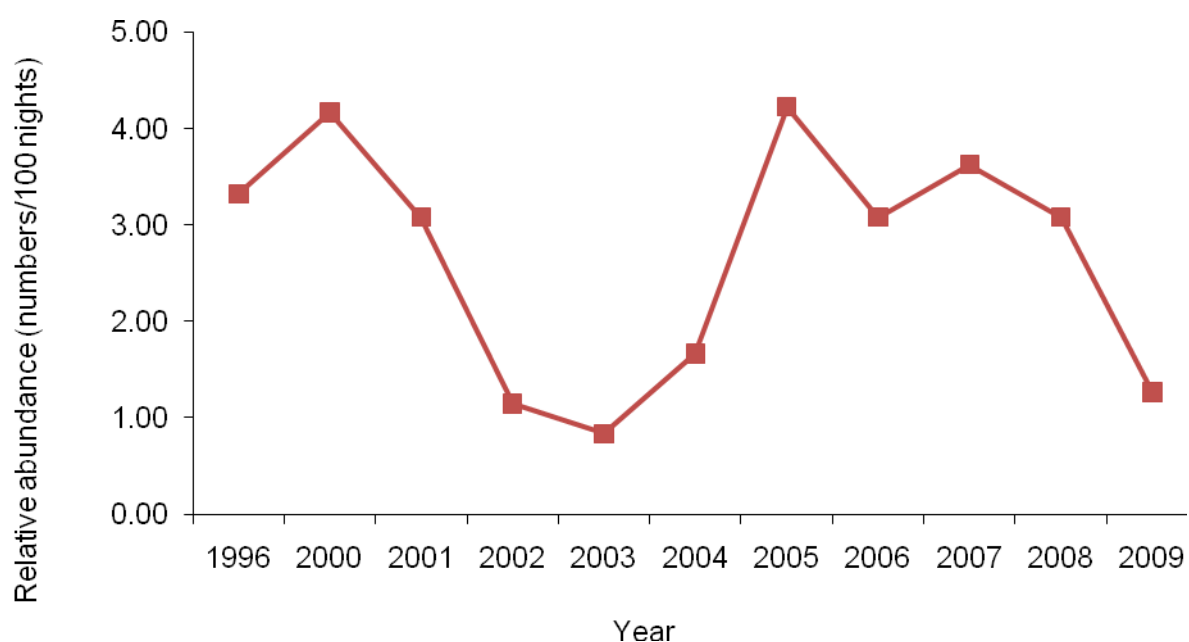


Figure 15. The relative abundance of ground dwelling mammal species caught at the "BU" trapping site for all years where fauna surveys have been undertaken.



Figure 16. The relative diversity of ground dwelling mammal species caught at the “BU” trapping sites for all years where fauna survey have been undertaken.

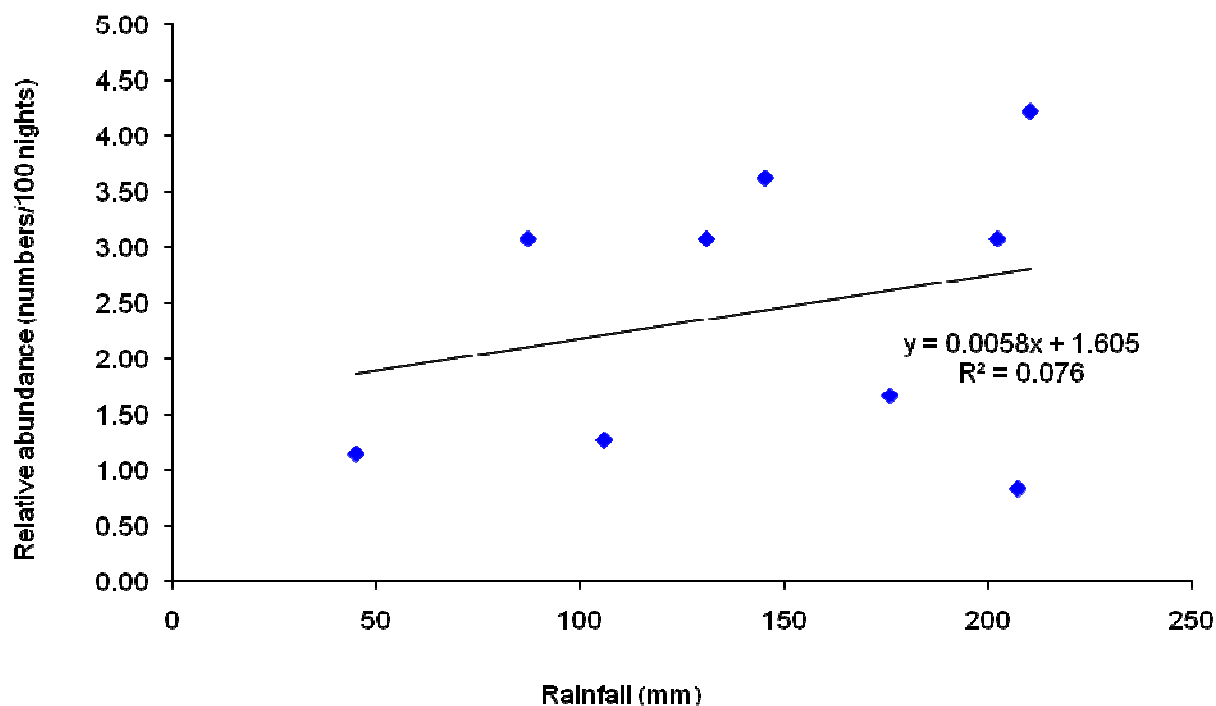


Figure 17. The correlation between the relative abundance of ground dwelling mammal species and rainfall, within each calendar year, at the “BU” trapping sites.

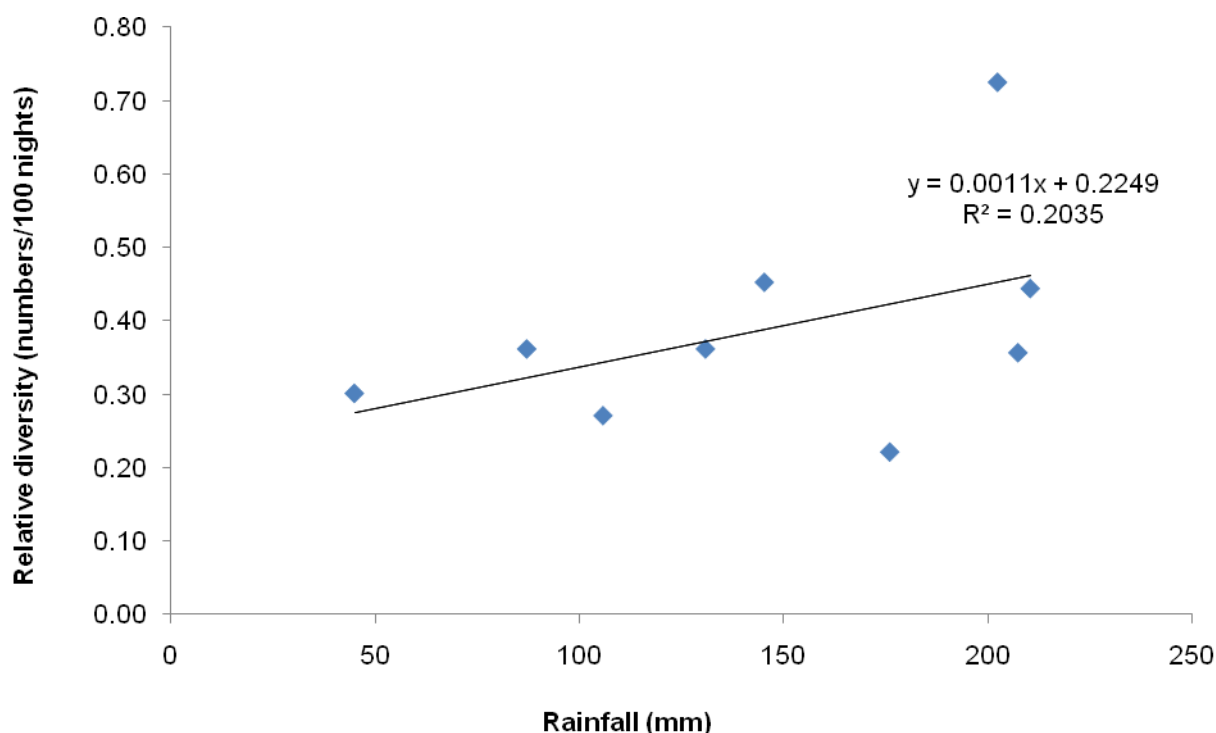


Figure 18. The correlation between the relative species diversity of ground dwelling mammal species and rainfall, within each calendar year, at the “BU” trapping sites.

3.4 Reptiles and Amphibians

3.4.1 Beverley Mine Sites

A total of 55 individuals and 16 reptile species were recorded during the 2009 survey of the Beverley Mine trapping sites (Table 14). Sites BU12 and BU13 recorded the highest abundance with 14 and 16 individuals recorded at each site whilst BU12 recorded the highest diversity with eight species recorded (Table 14). BEXT04 had the lowest reptile abundance with one individual being recorded while BU14 and BEXT04 had the lowest diversity with one species detected (Table 14).

A total of 10 skink, two gecko, two dragon and one legless lizard species were recorded at the Beverley Mine sites during the current survey (Table 14). No amphibian or snake species were recorded at any of the Beverley Mine sites in 2009 (Table 14). The most commonly recorded species at the Beverley Mine sites were the Eyrean Earless Dragon (*Tympanocryptis tetraporophora*) and the Wood Mulch Slider (*Lerista muelleri*), both with eight individuals recorded (Table 14). Several species were only recorded once including Desert Wall skink (*Cryptoblepharus plagiocephalus*), Black-necked Snake Lizard (*Delma tincta*), Bynoe’s Gecko (*Heteronotia binoei*), Smooth-snouted Earless Dragon (*Tympanocryptis intima*) and Sleepy Lizard (*Tiliqua rugosa*), which was found as a skeleton (Table 14).

Table 14. Reptiles recorded during the 2009 fauna survey of the Beverley Mine trapping sites.

Species Name	Common Name	BEXT02	BEXT03	BEXT04	BEXT05	BU11	BU12	BU13	BU14	BU15	BU16	TOTAL
<i>Cryptoblepharus plagiocephalus</i>	Desert Wall skink							1				1
<i>Ctenotus olympicus</i>	Saltbush Ctenotus				1						1	2
<i>Ctenotus regius</i>	Royal Striped Skink						4					4
<i>Ctenotus</i> sp										1		1
<i>Ctenotus strauchii</i>	Short-legged Ctenotus	1	2				1			1		5
<i>Delma tincta</i>	Black-necked Snake Lizard					1						1
<i>Gehyra variegata</i>	Tree Dtella			1		1	1					3
<i>Heteronotia binoei</i>	Bynoe's Gecko						1					1
<i>Lerista labialis</i>	Eastern Two-toed Slider						1	6				7
<i>Lerista muelleri</i>	Wood Mulch Slider						2	6				8
<i>Lerista punctatovittata</i>	Eastern Robust Slider						2	1				3
<i>Menetia greyii</i>	Dwarf Skink	1				2		1				4
<i>Morethia boulengeri</i>	Boulenger's Skink					1	2	2				5
<i>Tiliqua rugosa</i>	Sleepy Lizard				Sk							1
<i>Tympanocryptis intima</i>	Smooth-snouted Earless Dragon				1							1
<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon	2	2						2	1	1	8
Total observations for site		4	4	1	3	5	14	17	2	3	2	55
Total species for site		3	2	1	3	4	8	6	1	3	2	16

Sk = Skeleton species counted, abundance counted as 1

3.4.2 Control Sites

A total of 51 individuals and 14 reptile species were recorded during the 2009 survey of the Control sites (Table 15). Site CON08 had the highest abundance of reptiles with a total of 12 individuals being recorded at the site whilst site CON07 had the lowest abundance of reptiles with a total of three individuals recorded (Table 15). CON08 also had the highest diversity of reptiles at the Control sites with nine species being recorded whilst CON03 had the lowest diversity with just one species recorded (Table 15).

A total of eight skink, three gecko and three dragon species were recorded at the Control sites during the 2009 survey. No amphibian, snake or legless lizard species were recorded at any of the Control sites in 2009 (Table 15). The most commonly recorded species at the Control sites were the Eyrean Earless Dragon (*Tympanocryptis tetraporophora*) with 19 individuals and the Short-legged Ctenotus (*Ctenotus strauchii*) with 10 individuals recorded (Table 15). A total of seven species had only one individual recorded during the survey of the Control sites (Table 15). One species of Ctenotus, recorded at site CON08, could not be identified to species level as it was not sighted for long enough. It is possible that the reptile observed was a species that was recorded at other sites, possibly the Royal Striped Skink or the Short-legged Ctenotus which were recorded at other sites within the Control area (Table 15).

Table 15. Reptiles recorded during the 2009 fauna survey of the Control sites.

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	TOTAL
<i>Cryptoblepharus plagiocephalus</i>	Arboreal Snake-eyed Skink								1	1
<i>Ctenophorous nuchalis</i>	Central Netted Dragon	1								1
<i>Ctenotus regius</i>	Royal Striped Skink								1	1
<i>Ctenotus strauchii</i>	Short-legged Ctenotus	6					1	1	2	10
<i>Ctenotus</i> sp.									1	1
<i>Diplodactylus tessellatus</i>	Tessellated Gecko						1			1
<i>Gehyra variegata</i>	Tree Dtella							2	1	3
<i>Heteronotia binoei</i>	Bynoe's Gecko								2	2
<i>Lerista muelleri</i>	Wood Mulch Slider								1	1
<i>Menetia greyii</i>	Dwarf Skink				2	1				3
<i>Morethia boulengeri</i>	Boulenger's Skink				1				2	3
<i>Tiliqua rugosa</i>	Sleepy Lizard								1	1
<i>Tympanocryptis intima</i>	Smooth-snouted Earless Dragon		1		2					3
<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon		5	5	1	3	5			19
Total observations for site		7	6	5	6	4	7	3	12	51
Total species for site		2	2	1	4	2	3	2	9	14

3.4.3 Comparison Between Beverley Mine and Control Trapping Sites

The overall diversity and abundance of reptile species between the Beverley Mine and Control sites was similar with 16 species and 55 individuals being recorded at Beverley Mine sites, while the Control sites recorded 14 species and 51 individuals (Table 14 and 15). There were no significant differences between the Beverley and Control sites for either reptile abundance (two-sample t-test for unequal variances, $t(14) = -0.38$, $p=0.35$) or reptile diversity (two-sample t-test for unequal variances, $t(14) = 0.15$, $p=0.44$). Species recorded at Beverley Mine and Control sites differed, as the Central Netted Dragon (*Ctenophorous nuchalis*) and Tessellated Gecko (*Diplodactylus tessellatus*) were recorded only within the Control sites, while the Saltbush Ctenotus (*Ctenotus olympicus*), Black-necked Snake Lizard (*Delma tincta*), Eastern Two-toed slider (*Lerista labialis*) and Eastern Robust Slider (*Lerista punctatovittata*) were only recorded within the Beverley sites (Table 14 and 15).

Figure 19 shows that there is little difference in the reptile abundance and diversity between the minor drainage line and gibber habitat types. However, the major drainage line had a higher abundance and diversity of reptiles compared to the two other habitat types (Figure 19). Figure 19 also clearly shows that whilst there is variation in the abundance and diversity of reptiles, there is no clear difference between the Beverley sites and the Control sites, particularly when the habitat types are taken into consideration.

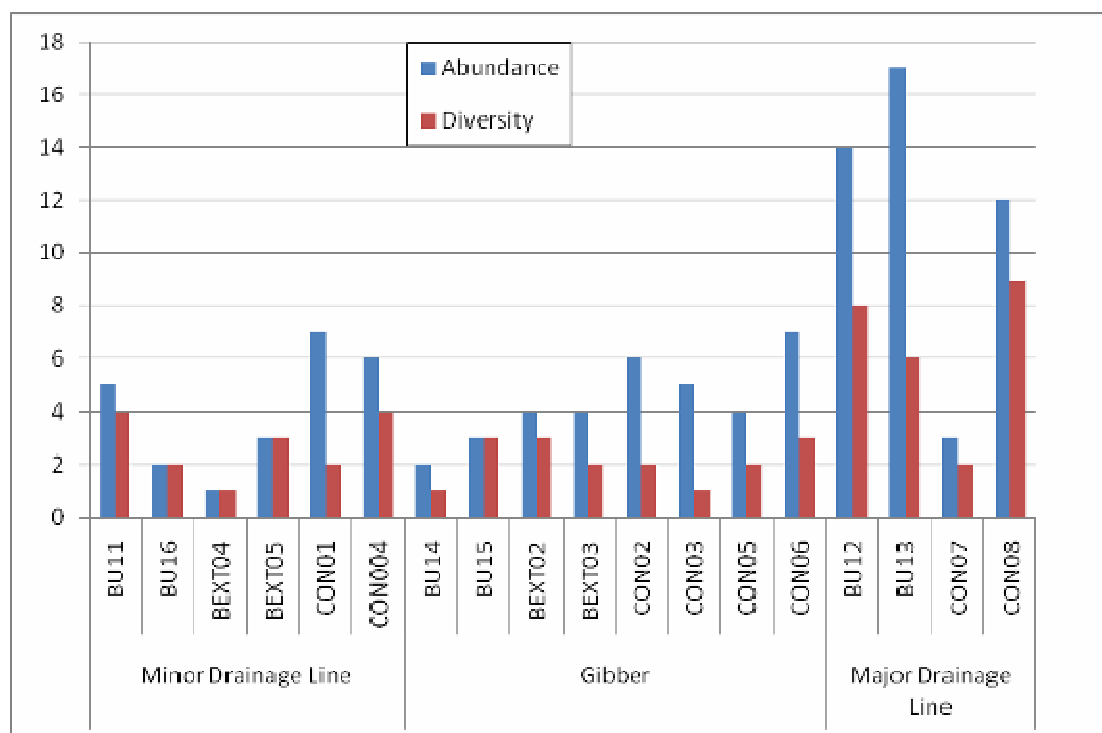


Figure 19. Comparison of reptile abundance and diversity between the Beverley Mine and Control sites for the 2009 fauna survey.

3.4.4 Comparison between 2007, 2008 and 2009 Results

Beverley Mine Sites

The data collected between 2007 and 2009 at the “BU” and “BEXT” sites can be compared directly as the survey methods have been consistent over this time. Over these three surveys, the results have varied with 2007 recording the highest abundance and diversity (with 89 individuals and 23 species recorded) and 2008 having the lowest recorded (48 individuals and 12 species) (Table 16). The results for 2009 were similar to 2008 with 55 individuals recorded and 16 species (Table 16). There was no significant difference in the abundance of reptiles across the survey years (ANOVA: $F(2,27) = 1.90$, $p = 0.17$), however there was a significant difference in reptile diversity across the survey years (ANOVA: $F(2,27) = 4.03$, $p = 0.029$). Figure 20 shows the species diversity at each site over the three years whilst Figure 21 shows the abundance over the same time period.

Table 16 shows that a total of ten species recorded in 2007 have not been recorded at the Beverley sites since. These include Central Netted Dragon (*Ctenophorus nuchalis*), gibber Gecko (*Diplodactylus byrnei*) and Beaked Gecko (*Rhynchoedura ornata*). One species recorded in 2009 has not been recorded at the Beverley sites in 2007 or 2008. This was the Smooth Snouted Earless Dragon (*Tympanocryptis intima*) (Table 16).

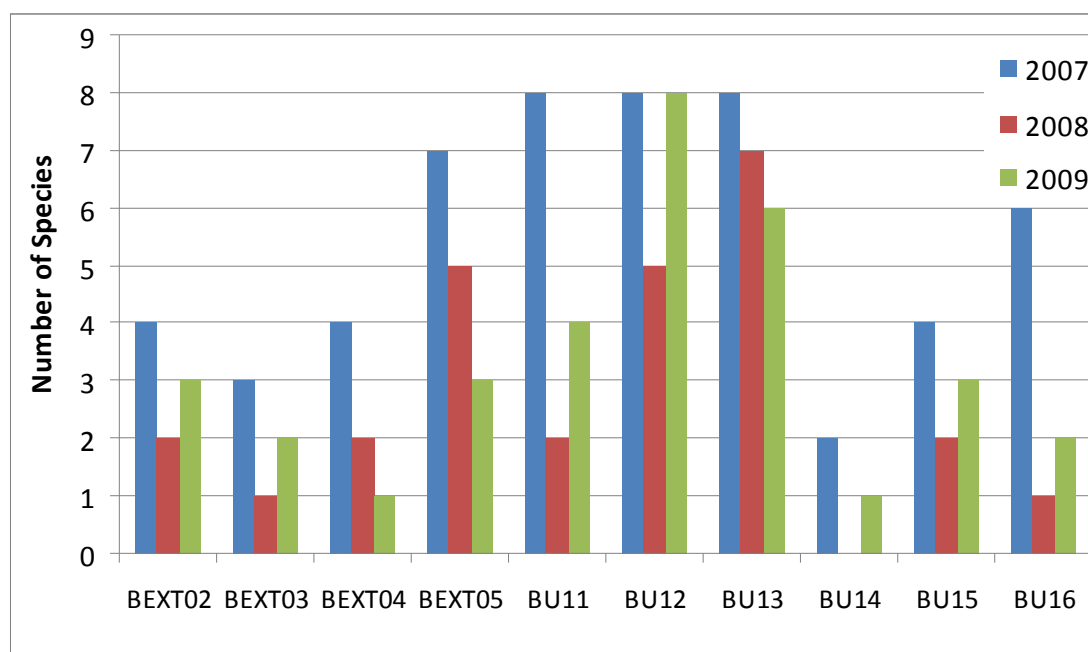


Figure 20. Species diversity for reptiles across Beverley Mine Sites between 2007, 2008 and 2009

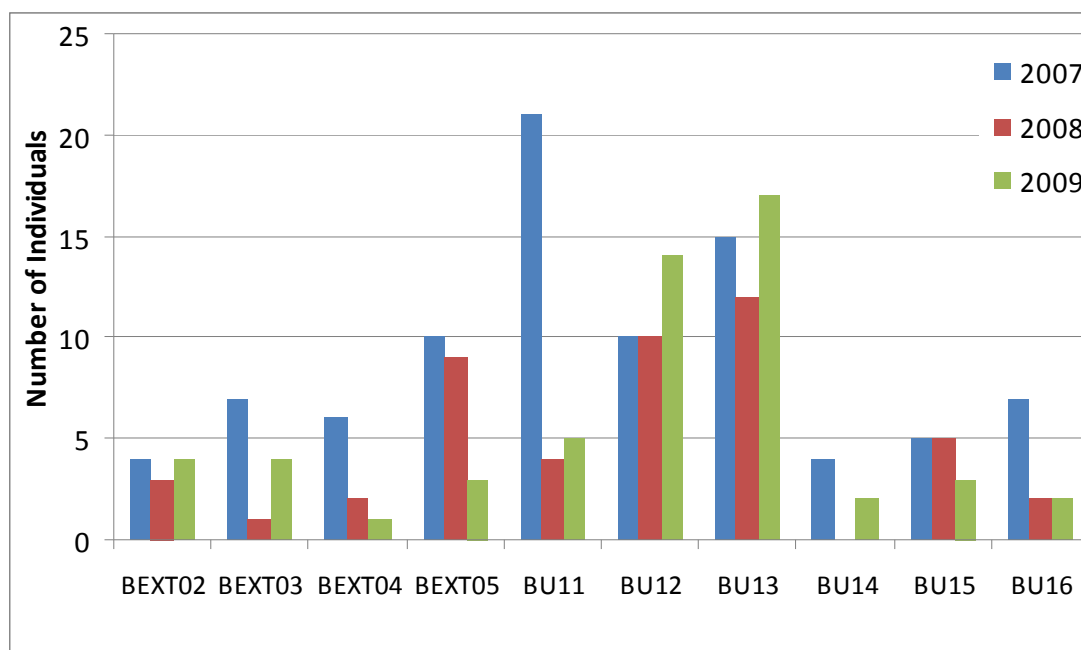


Figure 21. Species abundance for reptiles across Beverley Mine Sites between 2007, 2008 and 2009

Table 16. Reptiles recorded at the Beverley sites across 2007, 2008 and 2009.

Species Name	Common Name	BEXT02			BEXT03			BEXT04			BEXT05			BU11			BU12		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Cryptoblepharus plagiocephalus</i>	Desert Wall skink	1									1						1		
<i>Ctenophorus nuchalis</i>	Central Nettle Dragon										1								
<i>Ctenopus leonhardtii</i>	Common Desert Ctenopus	1											6						
<i>Ctenopus olympicus</i>	Saltbush Ctenopus												1	1					
<i>Ctenopus robustus</i>	Eastern Striped Skink													1					
<i>Ctenopus regius</i>	Royal Striped Skink																1	4	
<i>Ctenopus</i> sp.																			
<i>Ctenopus strauchii</i>	Short-legged Ctenopus	1		1	2	2												1	
<i>Delma tincta</i>	Black-necked Snake Lizard													1		1			
<i>Diplodactylus byrnei</i>	Gibber Gecko				2			2			1			1					
<i>Diplodactylus tessellatus</i>	Tessellated Gecko													1					
<i>Gehyra variegata</i>	Tree Drella							1	1	1	2	5		8		1	2	3	1
<i>Heteronotia binoei</i>	Bynoe's Gecko																	1	1
<i>Lerista labialis</i>	Eastern Two-toed Slider																1	3	1
<i>Lerista muelleri</i>	Wood Mulch Slider																2	2	2
<i>Lerista punctatovittata</i>	Eastern Robust Slider											1							
<i>Menetia greyii</i>	Dwarf Skink		2	1					1		1	1		2	3	2			
<i>Morethia boulengeri</i>	Boulenger's Skink											1		1	1	1	1		2
<i>Neobatrachus centralis</i>	Desert Trilling Frog																1		
<i>Nephurus levis</i>	Smooth Knob-tailed Gecko																1		
<i>Pogona vitticeps</i>	Central Bearded Dragon																1		
<i>Rhynchoedura ornata</i>	Beaked Gecko							2			3								
<i>Suta suta</i>	Curl Snake							1											
<i>Tiliqua rugosa</i>	Sleepy Lizard										1		Sk						
<i>Tympanocryptis intima</i>	Smooth-snouted Earless Dragon											1							
<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon	1	1	2	3	1	2												
<i>Varanus gouldii</i>	Gould's Sand Goanna										1	1							
Total observations for site		4	3	4	7	1	4	6	2	1	10	9	3	21	4	5	10	10	14
Total species for site		4	2	3	3	1	2	4	2	1	7	5	3	8	2	4	8	5	8

Sk = Skeleton species counted, abundance counted as 1

Table 16 continued

Species Name	Common Name	BU13			BU14			BU15			BU16			Total		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Cryptoblepharus plagiocephalus</i>	Desert Wall skink	1	3	1										3	3	1
<i>Ctenophorus nuchalis</i>	Central Netted Dragon													1	0	0
<i>Ctenotus leonhardii</i>	Common Desert Ctenotus	1												8	0	0
<i>Ctenotus olympicus</i>	Saltbush Ctenotus												1	1	0	2
<i>Ctenotus robustus</i>	Eastern Striped Skink													1	0	0
<i>Ctenotus regius</i>	Royal Striped Skink		1											0	2	4
<i>Ctenotus</i> sp.										1				0	0	1
<i>Ctenotus strauchii</i>	Short-legged Ctenotus				2			2	2	1	2			9	2	5
<i>Delma tincta</i>	Black-necked Snake	1									1			2	0	1
<i>Diplodactylus byrnei</i>	Gibber Gecko													7	0	0
<i>Diplodactylus tessellatus</i>	Tessellated Gecko													1	0	0
<i>Gehyra variegata</i>	Tree Drella	3												16	9	3
<i>Heteronotia binoei</i>	Bynoe's Gecko	1									1			2	1	1
<i>Lerista labialis</i>	Eastern Two-toed Slider		2	6										1	5	7
<i>Lerista muelleri</i>	Wood Mulch Slider	3	3	6										5	5	8
<i>Lerista punctatovittata</i>	Eastern Robust Slider		1	1										0	2	3
<i>Menetia greyii</i>	Dwarf Skink		1	1				1			1	2		5	10	4
<i>Morethia boulengeri</i>	Boulenger's Skink		1	2							1			2	3	5
<i>Neobatrachus centralis</i>	Desert Trilling Frog	2												3	0	0
<i>Nephurus levis</i>	Smooth Knob-tailed													1	0	0
<i>Pogona vitticeps</i>	Central Bearded Dragon							1			1			3	0	0
<i>Rhynchoedura ornata</i>	Beaked Gecko													5	0	0
<i>Suta suta</i>	Curl Snake													1	0	0
<i>Tiliqua rugosa</i>	Sleepy Lizard	3												4	0	1
<i>Tympanocryptis intima</i>	Smooth-snouted Earless													0	0	1
<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon				2		2	1	3	1			1	7	5	8
<i>Varanus gouldii</i>	Gould's Sand Goanna													1	1	0
Total observations for site		15	12	1	4	0	2	5	5	3	7	2	2	89	48	55
Total species for site		8	7	6	2	0	1	4	2	3	6	1	2	23	12	16

Sk = Skeleton species counted, abundance counted as 1

Control Sites

For the Control sites, only six sites were installed in 2008 whilst there were eight in 2009 (CON07 and CON08 were the additional sites). Overall, when comparing only the six control sites which have data for both years, 42 observations of 11 reptiles species were recorded in 2008 at the Control sites compared to 35 observations of seven species in 2009 (Table 16). The addition of two sites in 2009 resulted in an extra 15 observations of an additional seven species at the Control sites (total of 50 observations of 14 species in 2009 for all Control sites) (Table 16). When all data is included, there is no significant difference in the abundance (ANOVA: $F(1,12) = 0.12$, $p = 0.74$) or diversity (ANOVA: $F(1,12) = 0.33$, $p = 0.57$) of reptile species between 2008 and 2009 for the Control sites.

At the Control sites, five reptile species recorded in 2008 were not recorded in 2009 whilst in 2009 eight species were recorded which were not recorded in 2008 (Table 17). This data includes the two additional sites installed in 2009.

No difference in species diversity was recorded for sites CON05 and CON06 between the 2008 and 2009 surveys (Figure 22). The remaining sites all had a higher diversity in 2008 with CON01 recorded an additional four species in 2008 (Figure 22). Three of the Control sites recorded a higher abundance in 2008 compared to 2009 (Figure 23). CON05 recorded the same number of individuals each year whilst CON03 and CON06 recorded a higher number of individuals in 2009 (Figure 23).

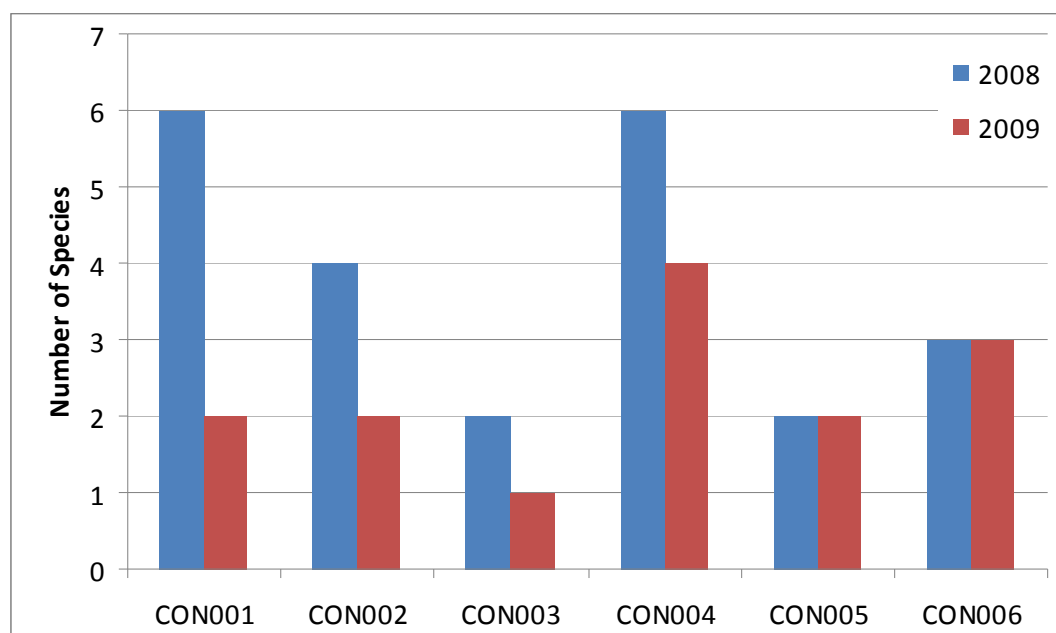


Figure 22. Comparison of reptile diversity across all survey years for the Control survey sites.

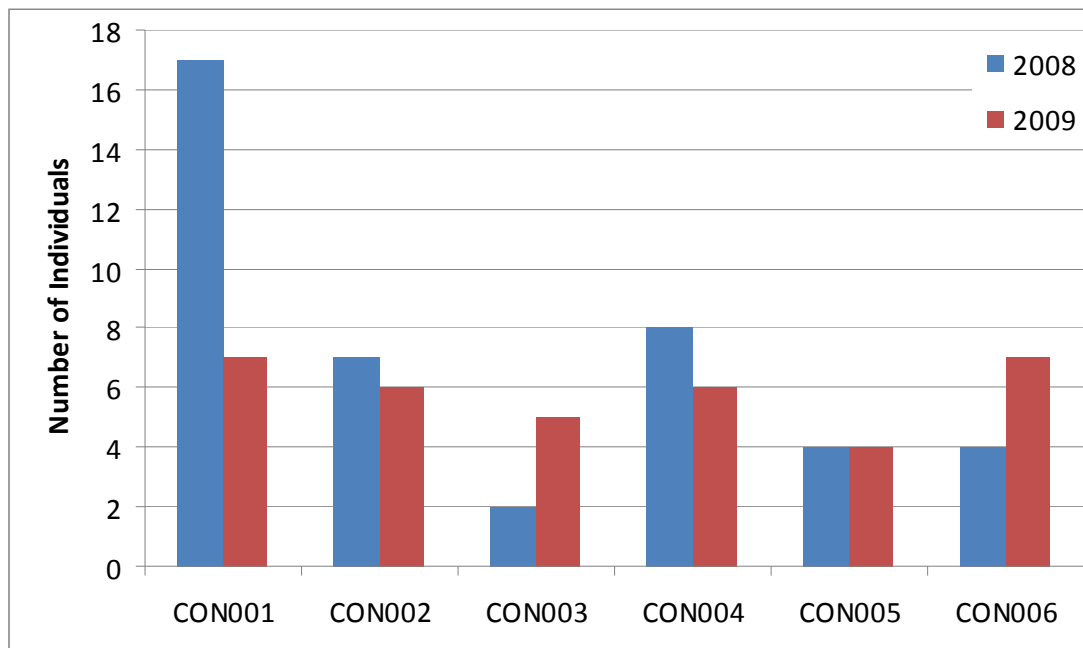


Figure 23. Comparison of reptile abundance across all survey years for the Control survey sites.

Table 17. Reptiles recorded during the 2008 and 2009 fauna survey of the Control sites.

Species Name	Common Name	CON001		CON002		CON003		CON004		CON005		CON006		CON07	CON08	Total	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009			2008	2009
<i>Cryptoblepharus plagiocephalus</i>	Arboreal Snake-eyed Skink														1	0	1
<i>Ctenophorus nuchalis</i>	Central Notted Dragon	1	1					1								2	1
<i>Ctenotus regius</i>	Royal Striped Skink							1							1	1	1
<i>Ctenotus strauchii</i>	Short-legged Ctenotus		6	4						1	1	2	1	1	2	7	10
<i>Ctenotus</i> sp.															1	0	1
<i>Diplodactylus tessellatus</i>	Tessellated Gecko											1				0	1
<i>Eremiascincus richardsonii</i>	Broad-banded Swimmer			1												1	0
<i>Gehyra variegata</i>	Tree Dtella	8												2	1	8	3
<i>Heteronotia binoei</i>	Bynoe's Gecko														2	0	2
<i>Lerista labialis</i>	Eastern Two-toed Slider	2														2	0
<i>Lerista muelleri</i>	Wood Mulch Slider														1	0	1
<i>Lerista puntatovittata</i>	Eastern Robust Slider			1				1								2	0
<i>Menetia greyii</i>	Dwarf Skink	1				1			2		1	1				3	3
<i>Morethia boulengeri</i>	Boulenger's Skink								1						2	0	3
<i>Pogona vitticeps</i>	Central Bearded Dragon							1								1	0
<i>Rhynchoedura ornata</i>	Beaked Gecko	2						3								5	0
<i>Tiliqua rugosa</i>	Sleepy Lizard														1	0	1
<i>Tympanocryptis intima</i>	Smooth-snouted Earless Dragon				1				2							0	3
<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon	3		1	5	1	5	1	1	3	3	1	5			10	19
Total observations for site		17	7	7	6	2	5	8	6	4	4	4	7	3	12	42	50
Total species for site		6	2	4	2	2	1	6	4	2	2	3	3	2	9	11	14

3.4.5 Comparison Between All Years for BU Trapping Sites

A comparison between the results of all years of the fauna monitoring has been undertaken for the “BU” sites as these are the only sites that currently have the long-term data collected. The main issue with analysing this data is inconsistent trapping efforts from year to year. However, the analysis undertaken converted the data to relative abundance and relative diversity of species which takes into account the trapping effort in any one year for the results achieved in that year. In 2000 and 2001, only trapping sites BU14 and BU15 were surveyed, both of these sites are within gibber habitat. These results have been left in the analysis, however, as only one of the three main habitat types was surveyed in these years, and it is likely that this will influence the results of the analysis. No rainfall data was available for 1996 and 2000 and therefore both years were left out of the correlation analysis between rainfall and diversity and abundance of reptiles.

The relative abundance and species diversity was calculated by grouping the data from all six “BU” sites together and dividing it by trap effort to display data as the abundance and diversity within a year per 100 trap nights. For reptile data, only data collected from pitfall traps was used to calculate the trap effort as they are generally not caught in Elliott or cage traps, although this does occur occasionally.

Figure 24 shows the relative abundance of reptile species at the “BU” trapping sites for all years where fauna surveys have been undertaken. The relative abundance of reptiles appears to be quite variable from year to year with low abundances recorded within the 2001 survey where five animals per 100 trap nights were recorded. This is possibly due to only two trap sites, both in gibber habitat, being surveyed in those years. The highest relative abundance of reptiles occurred in 2006 where more than 20 animals per 100 trap nights were recorded. The relative abundance of reptiles has decreased since 2006, although, data recorded in 2008 and 2009 is similar (Figure 24).

The relative diversity of reptile species has been more stable than the relative abundance of reptiles with less variation from year to year (Figure 25). In 2003 the highest diversity in reptiles was recorded with more than six species per 100 trap nights being recorded (Figure 25) whilst less than three species were recorded in 2001. However, as with the relative abundance of reptiles, the relative diversity has declined since 2006 with data recorded in 2008 and 2009 being similar (Figure 25).

There is a slight positive correlation between rainfall and the relative abundance of all reptile species recorded at the “BU” trapping sites (Figure 26). The correlation is not considered to be strong positive as there is a degree of variability in the data with several lower rainfall years recording a higher relative abundance of reptiles. This is also a similar result for the

relative reptile diversity. There is a slight correlation between rainfall and relative species diversity, however, the correlation is not strong (Figure 27).

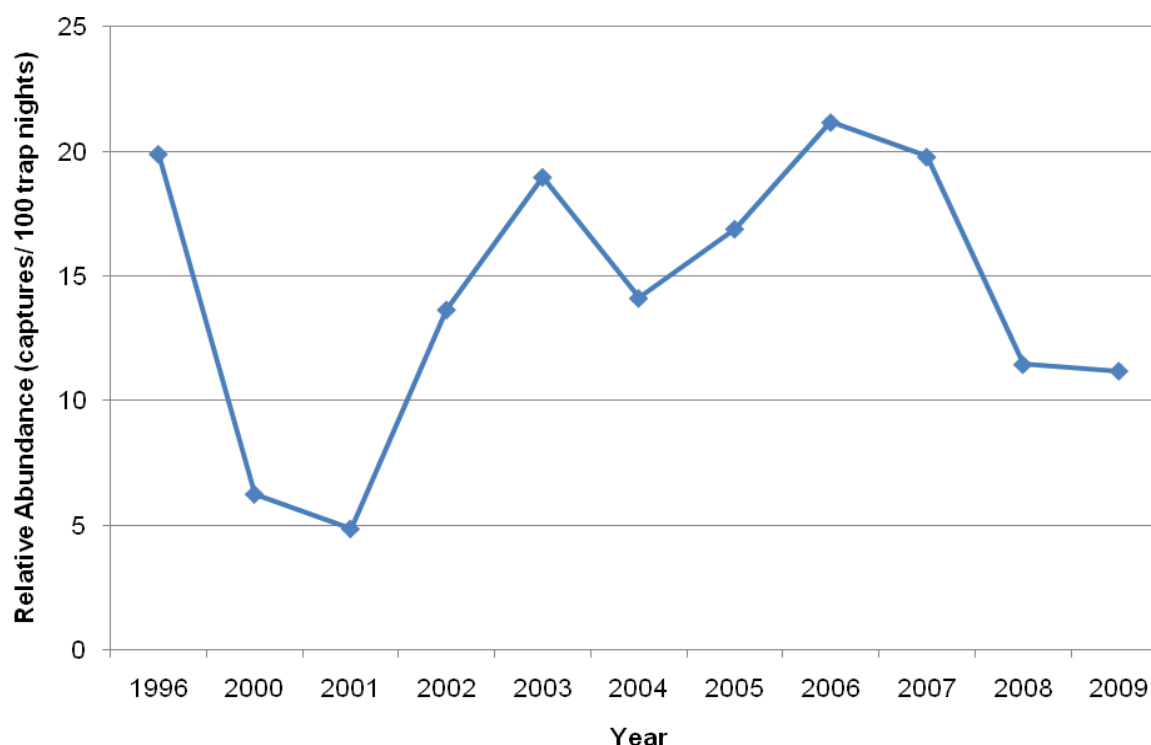


Figure 24. Relative abundance of reptile species at the “BU” trapping sites for all years where fauna surveys have been undertaken at the Beverley Mine site

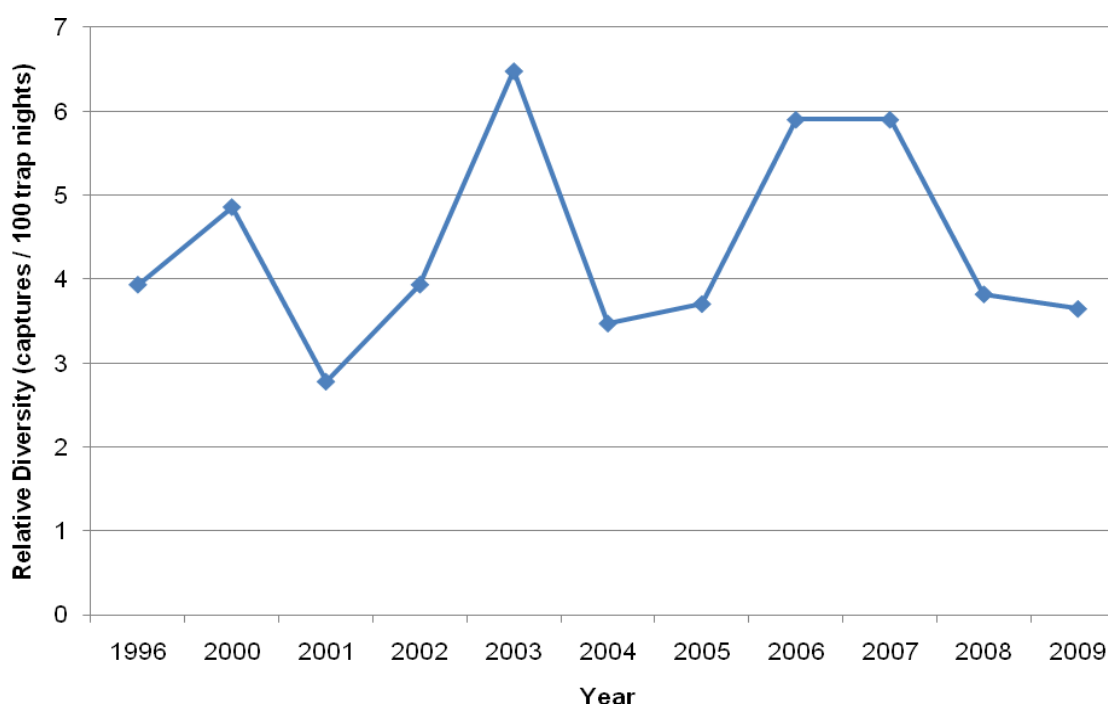


Figure 25. Relative diversity of reptile species at the “BU” trapping sites for all years where fauna surveys have been undertaken at Beverley Mine site.

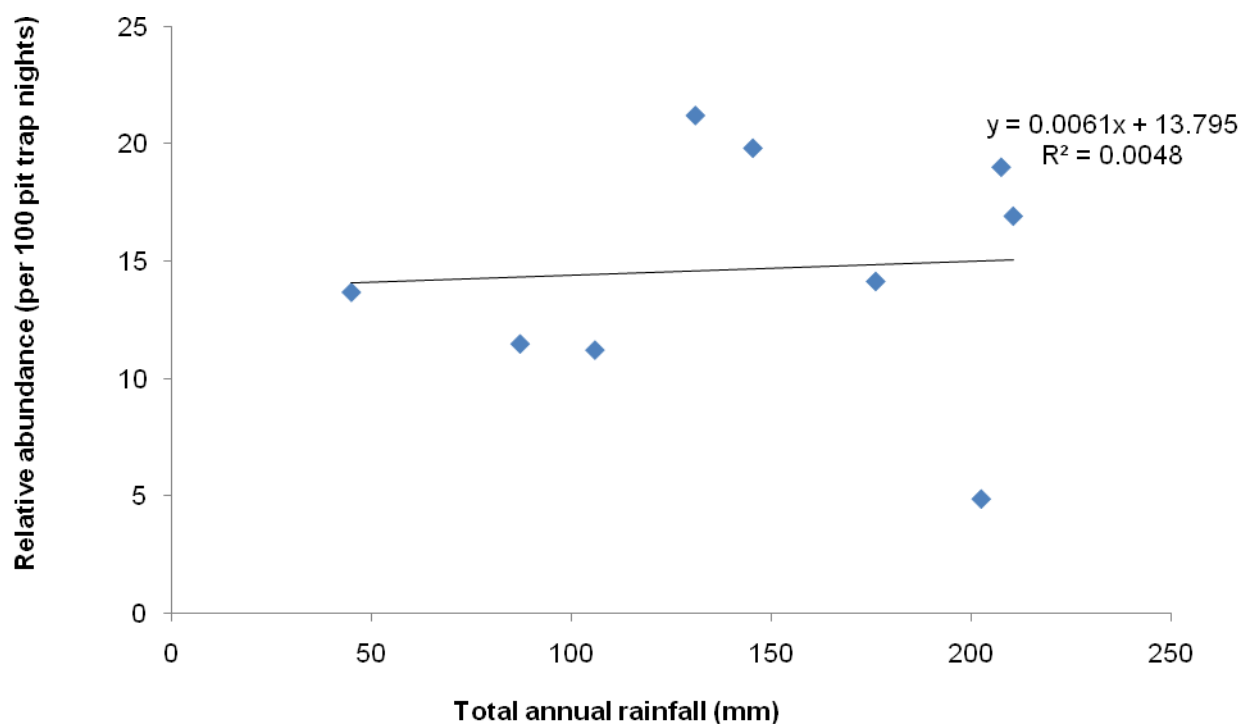


Figure 26. The correlation between the relative abundance of reptile species and rainfall, within each calendar year, at the “BU” trapping sites.

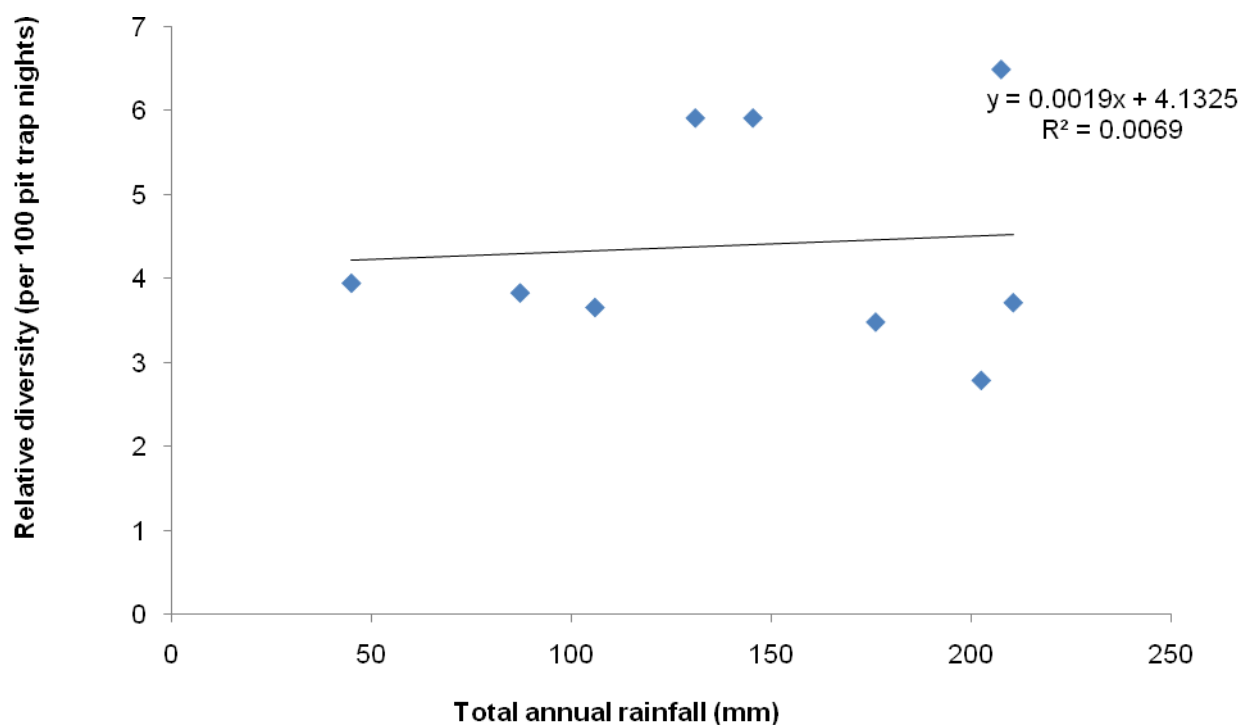


Figure 27. The correlation between the relative abundance of reptile species and rainfall, within each calendar year, at the “BU” trapping sites.

3.5 Birds

3.5.1 Beverley Mine Sites

A total of 39 bird species were recorded across the Beverley Mine sites during the 2009 survey with 340 individuals recorded (Table 18). Sites BEXT05 and BU12 had the highest abundance of birds with 63 and 81 individuals respectively. Sites BU13 and BU12 recorded the highest bird diversity with 22 and 25 species respectively (Table 18). The two sites are located within creek lines and are expected to have a higher diversity and abundance. Sites BEXT03 and BU14 had the lowest bird diversity with three species each, the sites also recorded the lowest abundance with seven and four individuals recorded respectively (Table 18). The low diversity and abundance of birds at these sites coincides with their Gibber plain landforms and therefore is to be expected.

The most commonly recorded bird species were the Galah (*Cacatua roseicapilla*) and the Crested Pigeon (*Ocyphaps lophotes*) with 34 and 36 individuals recorded respectively (Table 18). Seven of the 39 bird species recorded at the Beverley Mine sites were only recorded only once. This included the Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*), Brown Goshawk (*Accipiter fasciatus*), Southern Whiteface (*Aphelocephala leucopsis*), Little Corella (*Cacatua sanguine*), Grey Shrike-thrush (*Colluricincla harmonica*), Striated Pardalote (*Pardalotus striatus*), and the Red-backed Kingfisher (*Todirhamphus pyrrhopygia*) (Table 18). In contrast, the most common species occurring at eight of the ten Beverley Mine sites was the Australian Raven (*Corvus coronoides*) followed closely by the Wedge-tailed Eagle (*Aquila audax*) which occurred at seven of the ten Beverley Mine sites.

One species of Fairy-wren, recorded at site BU13, could not be identified to species level as it was not sighted for long enough to allow a correct identification. It is likely they were the common Variegated Fairy-wren or the White-winged Fairy-wren which were recorded at other sites within the Beverley Mine area (Table 18).

Table 18. Bird species recorded during the 2009 fauna survey of the Beverley Mine sites.

Species Name	Common Name	BEXT02	BEXT03	BEXT04	BEXT05	BU1	BU12	BU13	BU14	BU15	BU16	TOTAL
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater							2				2
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill						2	2				4
<i>Accipiter fasciatus</i>	Brown Goshawk							1				1
<i>Apeloecephala leucopsis</i>	Southern Whiteface						1					1
<i>Aquila audax</i>	Wedge-tailed Eagle	1		2	4	2	1	2			1	13
<i>Artamus cinereus</i>	Black-faced Woodswallow			4	2	1	3			1		11
<i>Artamus personatus</i>	Masked Woodswallow				10							10
<i>Barnardius zonarius</i>	Australian Ringneck						4					4
<i>Cacatua roseicapilla</i>	Galah	5		3			26					34
<i>Cacatua sanguinea</i>	Little Corella					Sk						1
<i>Cheramoeca leucosternus</i>	White-backed Swallow				4							4
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush	2		4						3		9
<i>Colluricincla harmonica</i>	Grey Shrike-thrush						1					1
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike							2				2
<i>Corvus coronoides</i>	Australian Raven	3	4	1			Sk	6	2	4	4	25
<i>Dromaius novaehollandiae</i>	Emu				Sc			Sc				2
<i>Epthianura tricolor</i>	Crimson Chat						2					2
<i>Falco cenchroides</i>	Australian Kestrel		1		1		2					4
<i>Gymnorhina tibicen</i>	Australian Magpie	1	2		2			2	1	2		10
<i>Hirundo nigricans</i>	Tree Martin					2	16	3				21
<i>Lalage tricolor</i>	White-winged Triller						1	1				2
<i>Lichenostomus penicillatus</i>	White-plumed honeyeater						2	1				3
<i>Lichenostomus virescens</i>	Singing Honeyeater	3		2	2	3	1	2				13
<i>Malurus lamberti</i>	Variegated Fairy-wren			6		7	4	12				29
<i>Malurus leucopterus</i>	White-winged Fairy-wren	3			14	6	3			2	3	31

Species Name	Common Name	BEXT02	BEXT03	BEXT04	BEXT05	BU11	BU12	BU13	BU14	BU15	BU16	TOTAL
<i>Malurus sp.</i>	Fairy-wren							1				1
<i>Manorina flavigula</i>	Yellow-throated Miner							2				2
<i>Merops ornatus</i>	Rainbow Bee-eater						1	3	1			5
<i>Milvus migrans</i>	Black Kite	1		1			1			1		4
<i>Ocyphaps lophotes</i>	Crested Pigeon			2	6		2	2		22	2	36
<i>Pachycephala rufiventris</i>	Rufous Whistler						1	1				2
<i>Pardalotus striatus</i>	Striated Pardalote						1					1
<i>Petroica goodenovii</i>	Red-capped Robin						1	2				3
<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler				9			5				14
<i>Psephotus varius</i>	Mulga Parrot							2				2
<i>Psophodes cristatus</i>	Chirruping Wedgebill			2	8	7	3				2	22
<i>Rhipidura leucophrys</i>	Willie Wagtail			2	1		1	2				6
<i>Smicrornis brevirostris</i>	Weebill			2								2
<i>Todirhamphus pyrrhopygia</i>	Red-backed Kingfisher						1					1
Total observations for site		19	7	31	63	28	81	56	4	35	12	340
Total species for site		8	3	12	13	8	25	22	3	7	5	39

Tr = track, species counted, abundance counted as 1; Sc = scat/feathers, species counted, abundance counted as 1.

3.5.2 Control Sites

Thirty-five bird species and 229 individuals were recorded during the 2009 survey of the Control sites (Table 19). Site CON08 had the highest abundance and diversity of birds with 105 individuals and 25 species being recorded (Table 19). The lowest abundance and diversity of birds was recorded at site CON02.

The most commonly recorded species at the Control sites were the White-winged Fairy-wren (*Malurus leucopterus*) and the Budgerigar (*Melopsittacus undulatus*) with 32 and 25 individuals recorded respectively (Table 19). Twenty one of the 35 bird species recorded at the Control sites were only recorded at one site, whilst the Australian Raven (*Corvus coronoides*) was recorded at most of the Control sites (Table 19).

Table 19. Bird species recorded during the 2009 fauna survey of the Control sites.

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	TOTAL
<i>Acanthiza apicalis</i>	Inland Thornbill								3	3
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill								10	10
<i>Anthus novaeseelandiae</i>	Richard's Pipit						2			2
<i>Aquila audax</i>	Wedge-tailed Eagle	1		1					1	3
<i>Artamus cinereus</i>	Black-faced Woodswallow		2			1			2	5
<i>Artamus personatus</i>	Masked Woodswallow								20	20
<i>Ashbyia lovensis</i>	Gibberbird			3						3
<i>Barnardius zonarius</i>	Australian Ringneck							4		4
<i>Cacatua roseicapilla</i>	Galah		2						2	4
<i>Cacatua sanguinea</i>	Little Corella							4		4
<i>Calamanthus campestris</i>	Rufous Fieldwren			1						1
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush			3						3
<i>Colluricincla harmonica</i>	Grey Shrike-thrush								2	2
<i>Corvus coronoides</i>	Australian Raven	1		2		2	1	1	3	10
<i>Dromaius novaehollandiae</i>	Emu			Sk				Tr	Sc	3
<i>Epianura tricolor</i>	Crimson Chat						5		1	6
<i>Falco berigora</i>	Brown Falcon	1								1
<i>Falco cenchroides</i>	Australian Kestrel		1	1	1	1			1	5
<i>Gymnorhina tibicen</i>	Australian Magpie				2	2	1	2		7
<i>Hirundo nigricans</i>	Tree Martin								14	14
<i>Lichenostomus virescens</i>	Singing Honeyeater	1							2	3
<i>Malurus lamberti</i>	Variegated Fairy-wren								10	10
<i>Malurus leucopterus</i>	White-winged Fairy-wren	6		15	11					32
<i>Melopsittacus undulatus</i>	Budgerigar						1	23	1	25
<i>Merops ornatus</i>	Rainbow Bee-eater							5	2	7
<i>Pachycephala rufiventris</i>	Rufous Whistler								2	2
<i>Pardalotus striatus</i>	Striated Pardalote								4	4
<i>Petroica goodenovii</i>	Red-capped Robin								5	5
<i>Pomatostomus superciliosus</i>	White-browed Babbler	4							5	9
<i>Psephotus varius</i>	Mulga Parrot								5	5
<i>Psophodes cristatus</i>	Chirruping Wedgebill	6								6
<i>Rhipidura leucophrys</i>	Willie Wagtail	1							2	3

Species Name	Common Name	CON01	CON02	CON03	CON04	CON05	CON06	CON07	CON08	TOTAL
<i>Smicrornis brevirostris</i>	Weebill								4	4
<i>Taeniopygia guttata</i>	Zebra Finch								2	2
<i>Todirhamphus pyrrhopygia</i>	Red-backed Kingfisher								2	2
Total observations for site		21	5	27	14	6	10	41	105	229
Total species for site		8	3	8	3	4	5	8	25	35

Tr = track, species counted, abundance counted as 1; Sc = scat, species counted, abundance counted as 1; Sk = skeleton, species counted, abundance counted as 1.

3.5.3 Comparison Between Beverley Mine and Control Sites

The overall diversity of bird species between the Beverley Mine and Control sites was similar with 39 species recorded at Beverley Mine sites, while the Control sites recorded 35 species (Table 18 and 19). The small difference in bird diversity between the two groups of sites was not significant (two-sample t-test for unequal variances, $t(13) = 0.38$, $p=0.71$). The Beverley Mine sites recorded 340 individuals which was a lot higher number than the 229 individuals recorded at the Control sites. The recorded difference in bird abundance was not significant between the two groups of sites (two-sample t-test for unequal variances, $t(15) = 0.74$, $p=0.47$). It should be noted however that there are ten sites within the Beverley trapping area and eight Control sites.

Species recorded at Beverley Mine and Control sites differed, with the Beverley Mine sites recording 10 species that were recorded at the Control Sites and six species recorded at the Control sites that were not recorded at the Beverley sites (Table 18 and 19).

Figure 28 indicates that the overall abundance and diversity of birds was higher within the major creekline habitat, particularly when compared to the gibber habitat. The minor creekline habitat had a higher diversity and abundance of birds compared to the gibber habitat (Figure 28). There is no clear pattern in the data when comparing the Beverley and Control sites within the different habitat types (Figure 28).

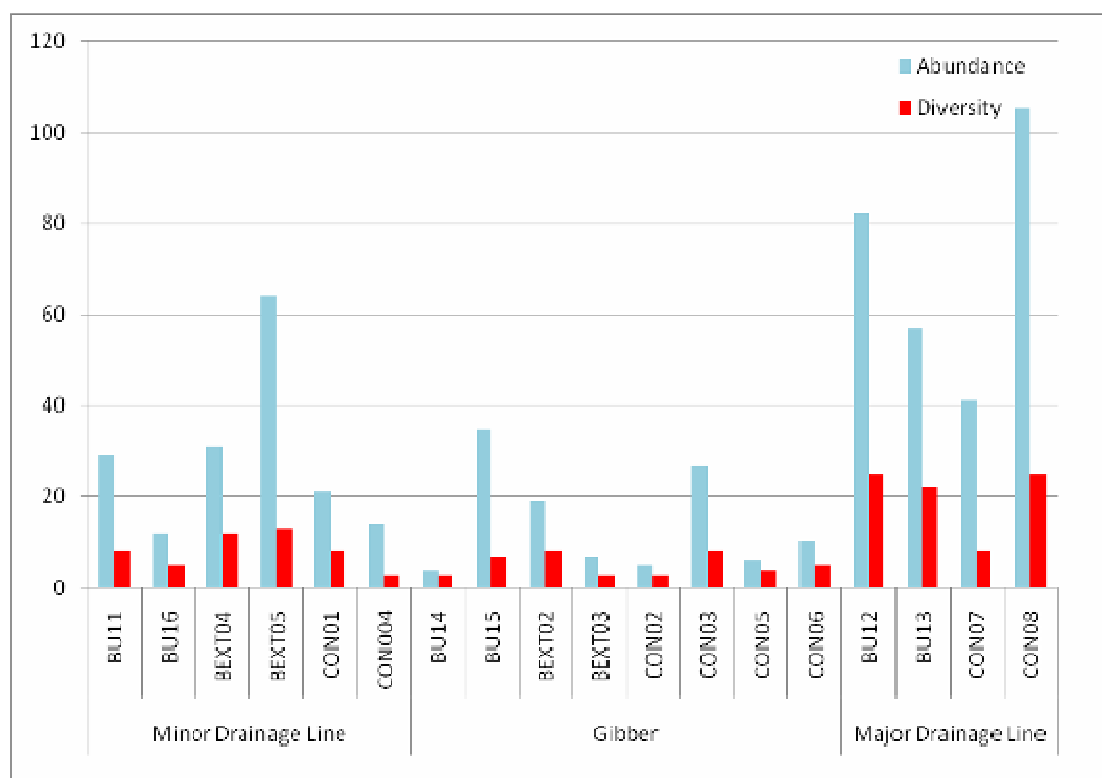


Figure 28. Comparison of bird abundance and diversity between the Beverley Mine and Control sites for the 2009 fauna survey.

3.5.4 Comparison between 2007, 2008 and 2009 Results

Beverley Mine Sites

The data collected between 2007 and 2009 at the “BU” and “BEXT” sites can be compared directly as the survey methods have been consistent over this time. Over these three surveys, the results have varied with 2007 recording the highest abundance and diversity (with 487 individuals and 40 species recorded) and 2008 having the lowest recorded (326 individuals and 32 species) (Table 20). The abundance of birds recorded in 2009 was similar to 2008 with 340 individuals recorded, however, the diversity was higher with 39 bird species recorded (Table 20). There was no significant difference in the abundance or diversity of birds across the survey years (abundance – ANOVA: $F(2,27) = 0.71$, $p = 0.50$; diversity – ANOVA: $F(2,27) = 0.51$, $p = 0.60$).

Figures 29 and 30 show the diversity of bird species and abundance of birds for each of the Beverley trapping sites for each of the three years (2007 to 2009). Table 25 shows that a total of seven species recorded in 2007 have not been recorded at the Beverley sites in 2008 or 2009. These include Horsefield’s Bronze Cuckoo (*Chrysococcyx basalis*) and White-fronted Honeyeater (*Phylidonyris albifrons*). Five species recorded in 2009 have not been recorded at the Beverley sites in 2007 or 2008 (Table 20). These include Masked Woodswallow (*Artamus peronatus*) and White-backed Swallow (*Cheramoeca leucosternus*) (Table 20).

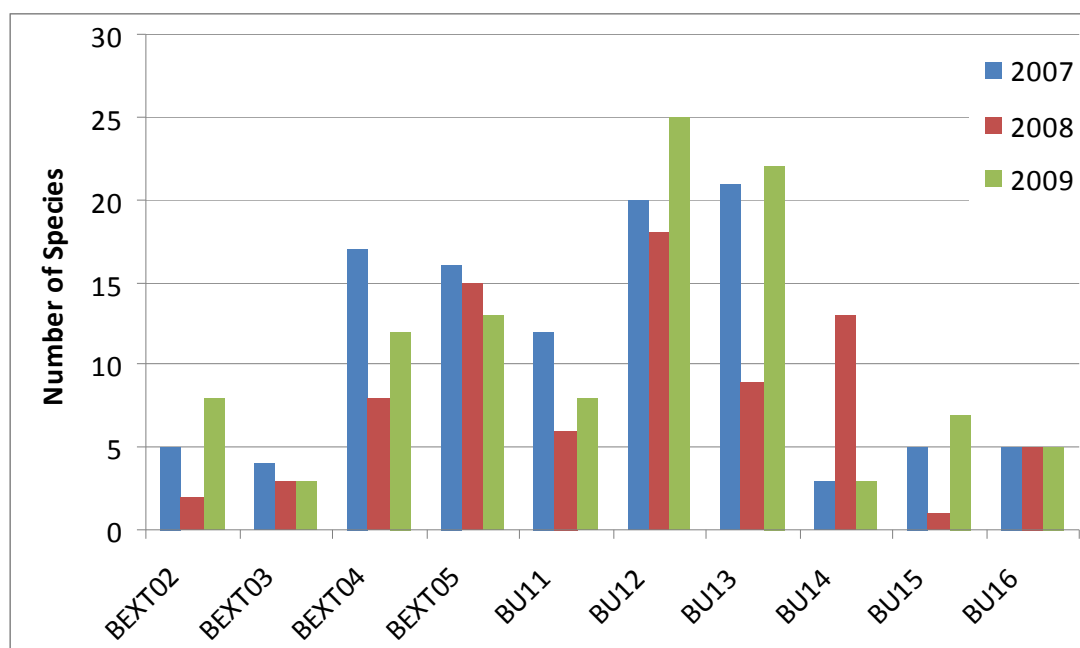


Figure 29. Species diversity for birds across Beverley Mine Sites between 2007, 2008 and 2009

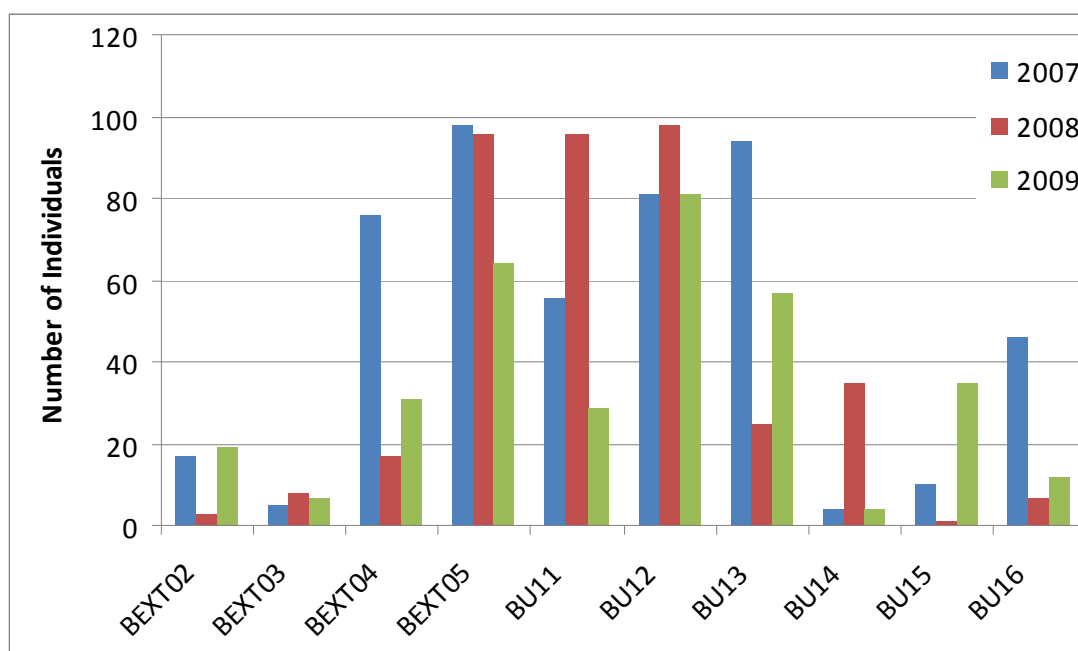


Figure 30. Species abundance for birds across Beverley Mine Sites between 2007, 2008 and 2009

Table 20. Bird species recorded during the 2007, 2008 and 2009 fauna survey of the Beverley Mine sites.

Species Name	Common Name	BEXT02			BEXT03			BEXT04			BEXT05			BU11			BU12		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	4						3	1			1				1	8	2	
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill																	1	
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill																		2
<i>Accipiter fasciatus</i>	Brown Goshawk																		
<i>Aegotheles cristatus</i>	Australian Owllet-nightjar																1		
<i>Anthus novaeseelandiae</i>	Richard's Pipit													1					
<i>Apheocephala leucopsis</i>	Southern Whiteface																5	1	1
<i>Aquila audax</i>	Wedge-tailed Eagle			1				1		2		4	4			2	1	1	1
<i>Artamus cinereus</i>	Black-faced Woodswallow	2				4		8		4	3	12	2	3		1			3
<i>Artamus personatus</i>	Masked Woodswallow												10						
<i>Barnardius zonarius</i>	Australian Ringneck																4	4	4
<i>Cacatua roseicapilla</i>	Galah			5				3		3				4			6		26
<i>Cacatua sanguinea</i>	Little Corella	6						2			8	16				Sk			
<i>Cheramoeca leucosternus</i>	White-backed Swallow											4							
<i>Chrysococcyx basalis</i>	Horsefield's Bronze-Cuckoo																2		
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush		1	2				6	2	4		2		2					
<i>Colluricincla harmonica</i>	Grey Shrike-thrush																		1
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike																		
<i>Corvus bennetti</i>	Little Crow				2			2									5		
<i>Corvus coronoides</i>	Australian Raven		2	3			4			1		1		3			2	2	Sk
<i>Dromaius novaehollandiae</i>	Emu							7				2	Sc						
<i>Epthianura tricolor</i>	Crimson Chat							2											2
<i>Eurostopodus argus</i>	Spotted Nightjar	2																	
<i>Falco berigora</i>	Brown Falcon													1				2	
<i>Falco cenchroides</i>	Australian Kestrel				1		1	1			1		1				1		2
<i>Grallina cyanoleuca</i>	Magpie-lark																		
<i>Gymnorhina tibicen</i>	Australian Magpie			1			2	5											
<i>Hirundo nigricans</i>	Tree Martin													8	22		17	26	16
<i>Lalage tricolor</i>	White-winged Triller														1				1
<i>Lichenostomus penicillatus</i>	White-plumed honeyeater											2					1	2	2

Species Name	Common Name	BEXT02			BEXT03			BEXT04			BEXT05			BU11			BU12		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Lichenostomus virescens</i>	Singing Honeyeater			3		3		8	4	2	2	4	2			3	5	3	1
<i>Malurus lamberti</i>	Variegated Fairy-wren									6						7		5	4
<i>Malurus leucopterus</i>	White-winged Fairy-wren	3		3							42	11	14	17	10	6			3
<i>Malurus sp.</i>	Fairy-wren																		
<i>Manorina flavigula</i>	Yellow-throated Miner																5	2	
<i>Melanodryas cucullata</i>	Hooded Robin																	2	
<i>Merops ornatus</i>	Rainbow Bee-eater													7			4	11	1
<i>Milvus migrans</i>	Black Kite			1						1									1
<i>Ocyphaps lophotes</i>	Crested Pigeon					1		13	1	2	2	8	6		3		3	6	2
<i>Pachycephala rufiventris</i>	Rufous Whistler																1	1	1
<i>Pardalotus striatus</i>	Striated Pardalote							4	1								3	9	1
<i>Petroica goodenovii</i>	Red-capped Robin										1			1			4		1
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater							2											
<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler										12		9		17			13	
<i>Pomatostomus superciliosus</i>	White-browed Babbler											9							
<i>Psephotus varius</i>	Mulga Parrot							4			6			11			2		
<i>Psophodes cristatus</i>	Chirruping Wedgebill							5	3	2	1		8	5	2	7		7	3
<i>Rhipidura leucophrys</i>	Willie Wagtail								1	2	4		1				3	4	1
<i>Smicromis brevirostris</i>	Weebill									2									
<i>Stiltia isabella</i>	Australian Pratincole				1														
<i>Todirhamphus pyrrhopygia</i>	Red-backed Kingfisher										2						1		1
Total observations for site		17	3	19	5	8	7	76	17	31	98	96	64	56	36	29	81	98	81
Total species for site		5	2	8	4	3	3	17	8	12	16	15	13	12	6	8	20	18	25

Sk = Skeleton, species counted, abundance counted as 1; Tr = track, species counted, abundance counted as 1; Sc = scat/feathers, species counted, abundance counted as 1.

Table 20 Continued

Species Name	Common Name	BU13			BU14			BU15			BU16			Total		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	9		2										24	6	2
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill													0	1	0
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	4		2										4	0	4
<i>Accipiter fasciatus</i>	Brown Goshawk	1	1	1										1	1	1
<i>Aegotheles cristatus</i>	Australian Owllet-nightjar													1	0	0
<i>Anthus novaeseelandiae</i>	Richard's Pipit						1	1						3	0	0
<i>Aphelocephala leucopsis</i>	Southern Whiteface													5	1	1
<i>Aquila audax</i>	Wedge-tailed Eagle	1		2				2				1	1	5	5	13
<i>Artamus cinereus</i>	Black-faced Woodswallow					1				1				16	17	11
<i>Artamus personatus</i>	Masked Woodswallow													0	0	10
<i>Barnardius zonarius</i>	Australian Ringneck	4	2											8	2	4
<i>Cacatua roseicapilla</i>	Galah	2												15	0	34
<i>Cacatua sanguinea</i>	Little Corella	3				2					25			44	18	1
<i>Cheramoeca leucosternus</i>	White-backed Swallow													0	0	4
<i>Chrysococcyx basalis</i>	Horsefield's Bronze-Cuckoo													2	0	0
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush							2		3	1	1		11	6	9
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	1												1	0	1
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			2										0	0	2
<i>Corvus bennetti</i>	Little Crow	9												20	0	0
<i>Corvus coronoides</i>	Australian Raven		11	6	1	4	2			4		2	4	4	22	25
<i>Dromaius novaehollandiae</i>	Emu	2		SC										12	2	2
<i>Epthianura tricolor</i>	Crimson Chat													4	0	2
<i>Eurostopodus argus</i>	Spotted Nightjar													2	0	0
<i>Falco berigora</i>	Brown Falcon	1												2	2	0
<i>Falco cenchroides</i>	Australian Kestrel	1						2	1			1		7	2	4
<i>Grallina cyanoleuca</i>	Magpie-lark					1								0	1	0
<i>Gymnorhina tibicen</i>	Australian Magpie			2			1					2		7	3	10
<i>Hirundo nigricans</i>	Tree Martin	10		3		6								36	58	21
<i>Lalage tricolor</i>	White-winged Triller			1										0	1	2

Species Name	Common Name	BU13			BU14			BU15			BU16			Total		
		2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
<i>Lichenostomus penicillatus</i>	White-plumed honeyeater	1		1	1									1	4	3
<i>Lichenostomus virescens</i>	Singing Honeyeater	5	2	2		3					5			25	22	13
<i>Malurus lamberti</i>	Variegated Fairy-wren	14	2	12		1								14	8	29
<i>Malurus leucopterus</i>	White-winged Fairy-wren					8				2			3	65	29	31
<i>Malurus sp.</i>	Fairy-wren		1	1										0	1	1
<i>Manorina flavigula</i>	Yellow-throated Miner			2										5	2	2
<i>Melanodryas cucullata</i>	Hooded Robin													0	2	0
<i>Merops ornatus</i>	Rainbow Bee-eater		2	3			1							11	13	5
<i>Milvus migrans</i>	Black Kite									1				0	0	4
<i>Ocyphaps lophotes</i>	Crested Pigeon	11	2	2		3				22			2	29	24	36
<i>Pachycephala rufiventris</i>	Rufous Whistler	5		1										6	1	2
<i>Pardalotus striatus</i>	Striated Pardalote	3				3								10	13	1
<i>Petroica goodenovii</i>	Red-capped Robin	4	2	2		1								10	3	3
<i>Phylidonyris albigrons</i>	White-fronted Honeyeater													2	0	0
<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler			5										12	0	14
<i>Pomatostomus superciliosus</i>	White-browed Babbler													0	39	0
<i>Psephotus varius</i>	Mulga Parrot			2							6			29	0	2
<i>Psophodes cristatus</i>	Chirruping Wedgebill										9		2	20	12	22
<i>Rhipidura leucophrys</i>	Willie Wagtail	3		2										10	5	6
<i>Smicromis brevirostris</i>	Weebill													0	0	2
<i>Stiltia isabella</i>	Australian Pratincole													1	0	0
<i>Todirhamphus pyrrhopygia</i>	Red-backed Kingfisher													3	0	1
Total observations for site		94	25	57	4	35	4	10	1	35	46	7	12	487	326	340
Total species for site		21	9	22	3	13	3	5	1	7	5	5	5	40	32	39

Sk = Skeleton, species counted, abundance counted as 1; Tr = track, species counted, abundance counted as 1; Sc = scat/feathers, species counted, abundance counted as 1.

Control Sites

Six of the Control sites have been surveyed for two years, whilst two sites were only installed in 2009. Overall, when comparing only the six control sites which have data for both years, 110 observations of 19 bird species were recorded in 2008 at the Control sites compared to 85 observations of 19 species in 2009 (21). The addition of two sites in 2009 resulted in an extra 144 observations of an additional 16 species at the Control sites (total of 229 observations of 35 species in 2009 for all Control sites) (Table 21). When all data is included, there is no significant difference in the abundance (ANOVA: $F(1,12) = 0.56$, $p = 0.56$) or diversity (ANOVA: $F(1,12) = 0.6$, $p = 0.45$) of bird species between 2008 and 2009 for the Control sites.

Eight of the species recorded at the Control sites in 2009 had not been previously recorded at the Control sites whilst nine species recorded in 2008 at these sites were not recorded in 2009 (Table 21). The diversity of bird species, within a Control site, was similar between years (Figure 31), however, CON002 dropped from eight species in 2008 to three species in 2009. The abundance of bird species within Control sites shows some minor differences between the years but no clear pattern is forming at this stage. Sites CON002 and CON006 had a higher number of birds recorded in 2008 compared to 2009 whilst CON003 had more recorded in 2009 (Figure 32).

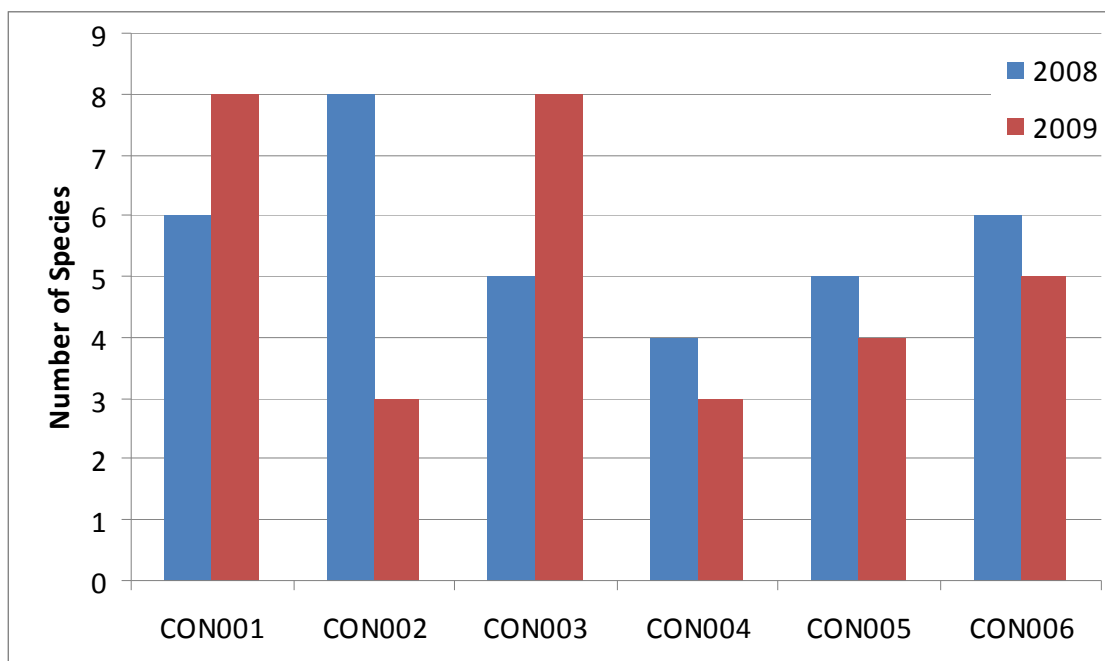


Figure 31. Comparison of bird diversity across all survey years for the Control survey sites.

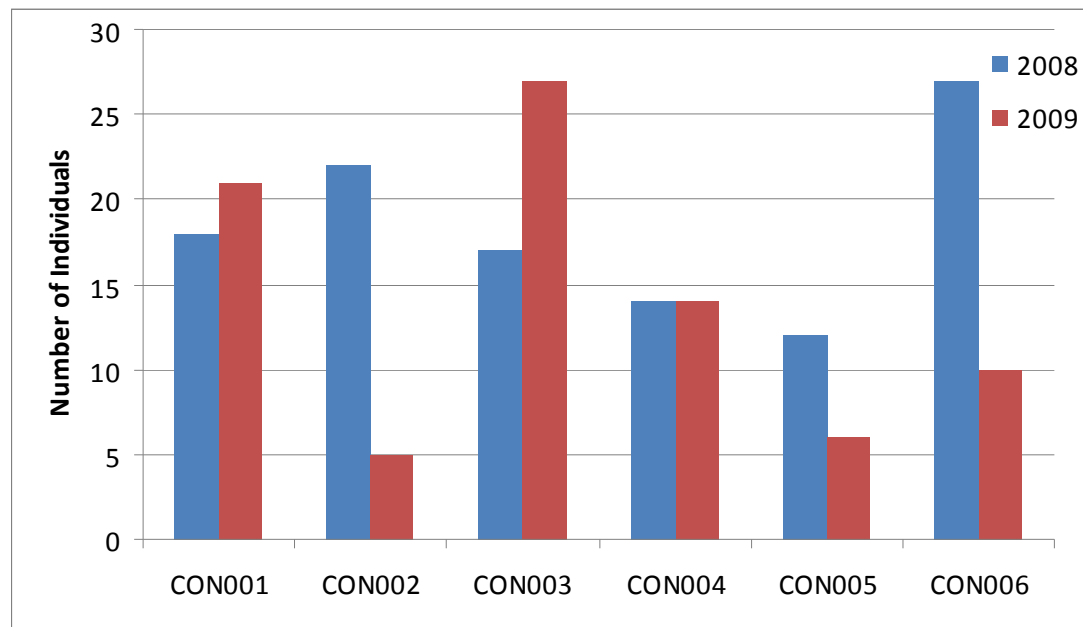


Figure 32. Comparison of bird abundance across all survey years for the Control survey sites.

Table 21. Bird species recorded during the 2008 and 2009 fauna survey of the Control sites.

Species Name	Common Name	CON01		CON02		CON03		CON04		CON05		CON06		CON07	CON08	Total	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009		2009	2008	2009
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	2										4				6	0
<i>Acanthiza apicalis</i>	Inland Thornbill														3	2	3
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill														10	0	10
<i>Anthus novaeseelandiae</i>	Richard's Pipit											2				0	2
<i>Apeloecephala leucopsis</i>	Southern Whiteface															0	0
<i>Aquila audax</i>	Wedge-tailed Eagle	1				1				1					1	3	3
<i>Artamus cinereus</i>	Black-faced Woodswallow				2	4		1		5	1				2	10	5
<i>Artamus personatus</i>	Masked Woodswallow														20	3	20
<i>Ashbyia lovensis</i>	Gibberbird						3									0	3
<i>Barnardius zonarius</i>	Australian Ringneck													4		1	4
<i>Cacatua roseicapilla</i>	Galah				2										2	0	4
<i>Cacatua sanguinea</i>	Little Corella													4		1	4
<i>Calamanthus campestris</i>	Rufous Fieldwren						1									0	1
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush					1	3			1						2	3
<i>Colluricincla harmonica</i>	Grey Shrike-thrush														2	0	2
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike															0	0
<i>Corvus coronoides</i>	Australian Raven		1	1			2				2	1	1	1	3	4	10
<i>Dromaius novaehollandiae</i>	Emu						Sk							Tr	Sc	0	3
<i>Eplanura tricolor</i>	Crimson Chat											5			1	0	6
<i>Falco berigora</i>	Brown Falcon		1													0	1
<i>Falco cenchroides</i>	Australian Kestrel	1			1		1		1			1			1	3	5
<i>Grallina cyanoleuca</i>	Magpie-lark			2												4	0
<i>Gymnorhina tibicen</i>	Australian Magpie					1			2		2	1		2		1	7
<i>Hirundo nigricans</i>	Tree Martin											16			14	16	14

Species Name	Common Name	CON01		CON02		CON03		CON04		CON05		CON06		CON07	CON08	Total	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2009	2009	2008	2009
<i>Lichenostomus penicillatus</i>	White-plumed honeyeater			1												5	0
<i>Lichenostomus virescens</i>	Singing Honeyeater	1	1	3						3					2	12	3
<i>Malurus lamberti</i>	Variegated Fairy-wren			2								3			10	10	10
<i>Malurus leucopterus</i>	White-winged Fairy-wren		6	5		10	15		11							20	32
<i>Malurus sp.</i>	Fairy-wren					1		6								7	0
<i>Melopsittacus undulatus</i>	Budgerigar											1	23		1	2	25
<i>Merops ornatus</i>	Rainbow Bee-eater												5		2	4	7
<i>Ocyphaps lophotes</i>	Crested Pigeon	12		5						2						21	0
<i>Pachycephala rufiventris</i>	Rufous Whistler														2	2	2
<i>Pardalotus striatus</i>	Striated Pardalote							2				2			4	4	4
<i>Petroica goodenovii</i>	Red-capped Robin														5	0	5
<i>Pomatostomus superciliosus</i>	White-browed Babbler		4												5	0	9
<i>Psephotus varius</i>	Mulga Parrot														5	0	5
<i>Psophodes cristatus</i>	Chirruping Wedgebill		6					5								5	6
<i>Rhipidura leucophrys</i>	Willie Wagtail	1	1	3											2	4	3
<i>Smicromis brevirostris</i>	Weebill														4	0	4
<i>Taeniopygia guttata</i>	Zebra Finch														2	0	2
<i>Todirhamphus pyrrhopygia</i>	Red-backed Kingfisher	1													2	1	2
Total observations for site		18	21	22	5	17	27	14	14	12	6	27	10	41	105	153	229
Total species for site		6	8	8	3	5	8	4	3	5	4	6	5	8	25	26	35

Sk = Skeleton, species counted, abundance counted as 1; Tr = track, species counted, abundance counted as 1.

3.5.5 Comparison Between All Years for BU Trapping Sites

A comparison between the bird survey results of all years of the fauna monitoring has been undertaken for the “BU” sites. These are the only sites that currently have the long-term data collected, however, the bird data cannot be analysed pre 2002 as detailed information on the abundance and diversity at each survey site is not currently available. Additionally, no bird surveys were undertaken in 2003. The survey effort has varied year to year, however, the analysis undertaken converted the data to relative abundance and relative diversity of species. This takes into account the bird survey effort and expresses data as the abundance or diversity of birds per 30 minutes of survey effort.

Figures 25 and 26 show the relative abundance and relative diversity, respectively, of the bird species recorded between 2002 and 2009 except for 2003 (no data available). The two figures show a very similar trend with a higher relative abundance and relative diversity recorded in 2004 compared to other years. The abundance and diversity of bird species slowly declines from 2004 to reach low points in 2008 before increasing slightly in 2009 (Figures 33 and 34).

There is a highly positive correlation between rainfall and the relative abundance and relative diversity of bird species (Figures 35 and 36). This means that the higher the rainfall in the 12 months preceding the survey, the higher the abundance and diversity of bird species will be recorded during the annual fauna surveys. There is very little variation in the data when correlating the rainfall with both the relative abundance and relative diversity (Figures 35 and 36).

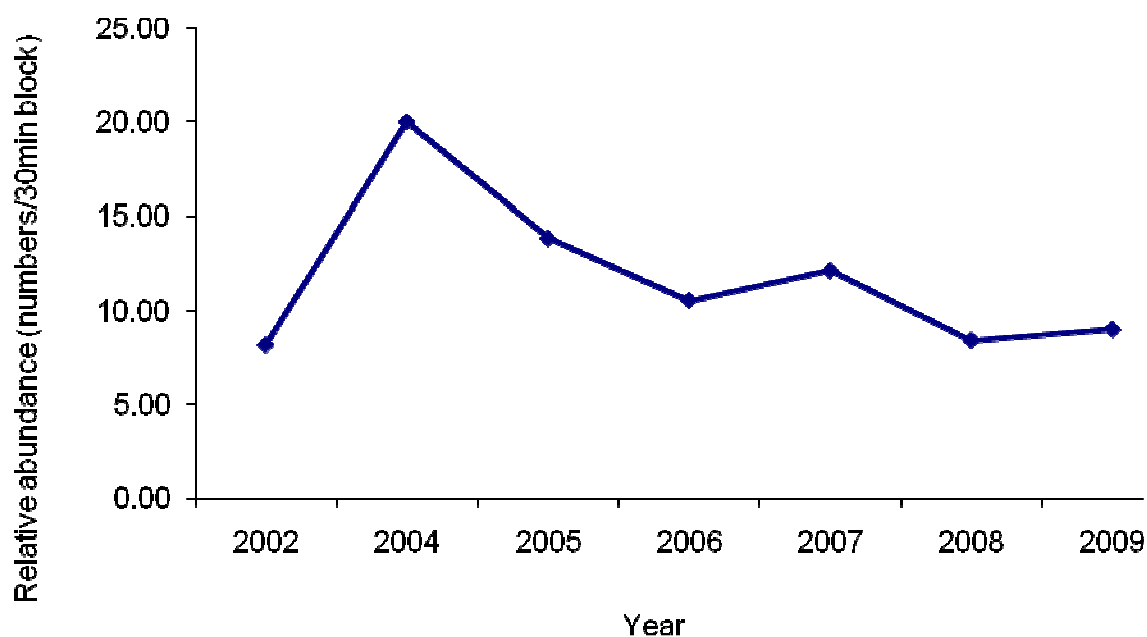


Figure 33. Relative abundance of bird species at the “BU” trapping sites for all years where detailed bird data is available.

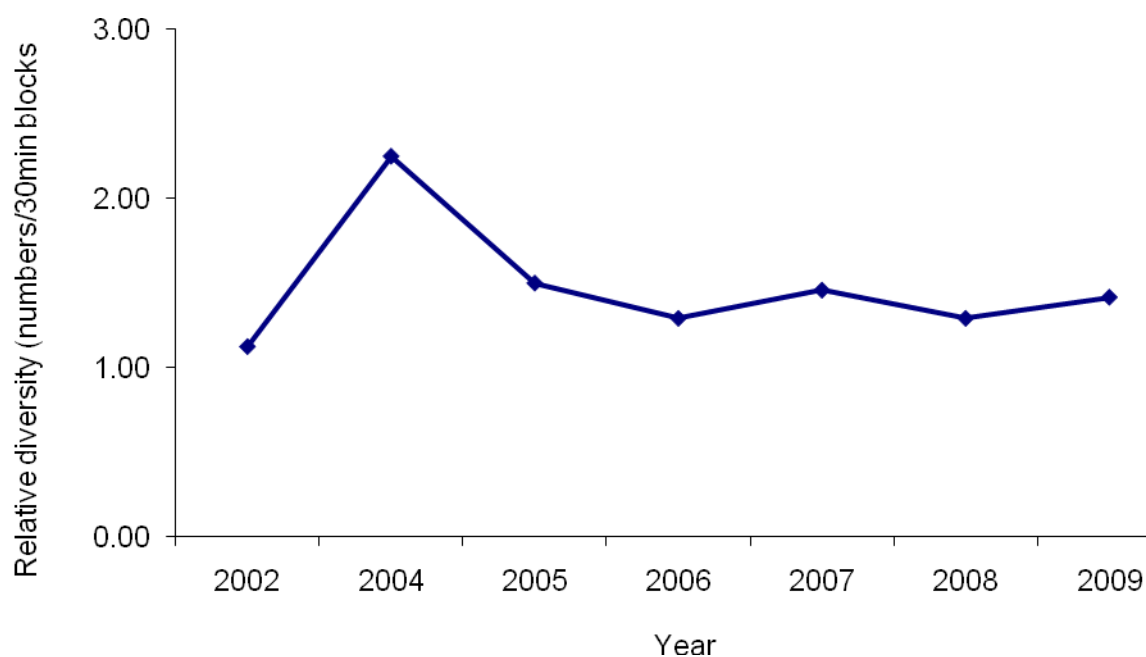


Figure 34. Relative diversity of bird species at the “BU” trapping sites for all years where detailed bird data is available.

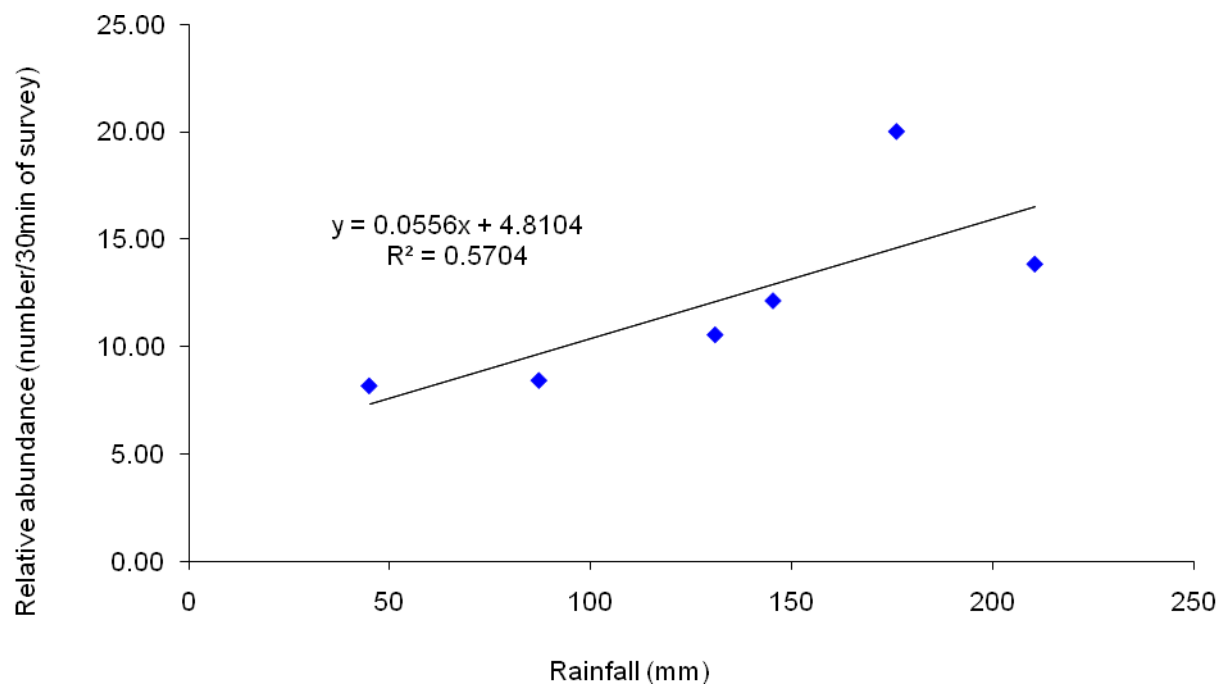


Figure 35. The correlation between the relative abundance of bird species and rainfall at the “BU” trapping sites for all years where detailed bird and rainfall data is available.

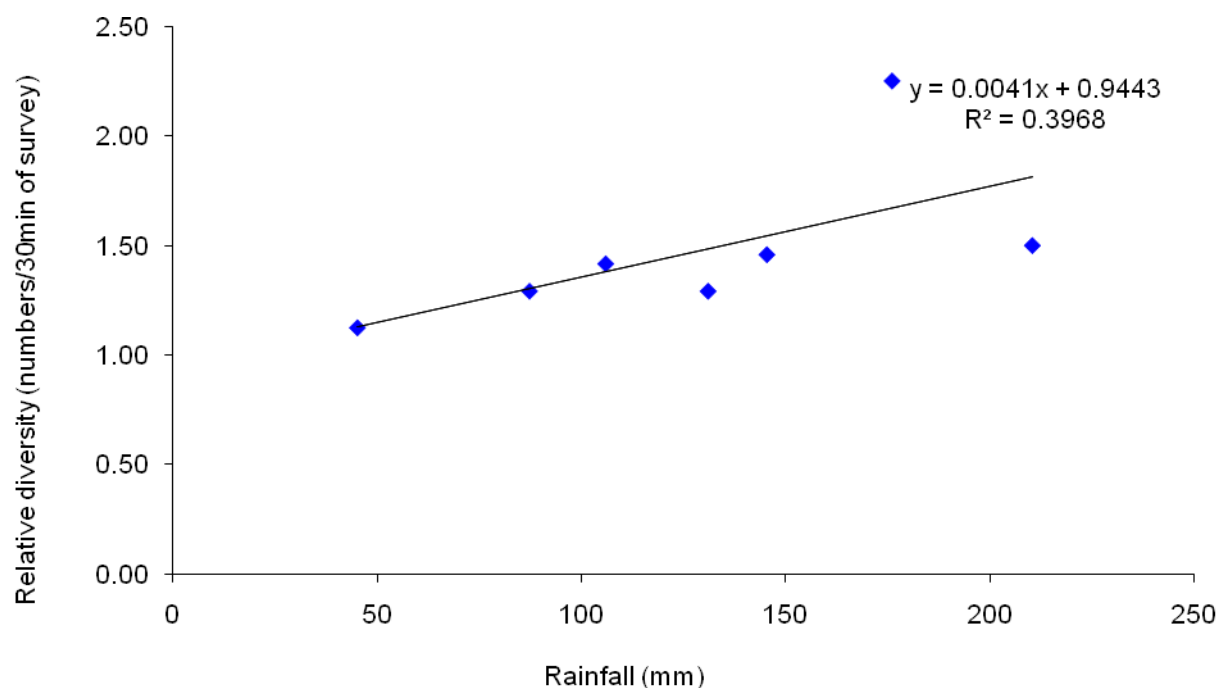


Figure 36. The correlation between the relative diversity of bird species and rainfall at the “BU” trapping sites for all years where detailed bird and rainfall data is available.

3.6 Opportunistic Observations – All Species

During the 2009 survey a number of opportunistic observations were made across the project area. Due to the nature of the opportunistic observations and the fact that these cannot be assigned specifically to a Beverley Mine site or Control site, the observations have been included in a separate section. These are valuable observations, and whilst it is difficult to quantify the records year to year (as the survey effort cannot be determined), these records can provide records of species not detected at the trapping sites.

Six mammal species were observed opportunistically during the survey. These were Feral Cat (*Felis catus*), Echidna (*Tachyglossus aculeatus*), Fat-tailed Dunnart (*Sminthopsis crassicaudata*), Euro (*Macropus robustus*), Red Kangaroo (*Macropus rufus*) and the introduced Rabbit (*Oryctolagus cuniculus*). All of these species were also recorded at trapping sites across the project area.

Three reptile species were recorded opportunistically during the survey. These were Tree Dtella (*Gehyra variegata*), Central Bearded Dragon (*Pogona vitticeps*) and Sleepy Lizard (*Tiliqua rugosa*). The Central Bearded Dragon was the only species, of the three observed opportunistically, not recorded at either the Beverley sites or the Control sites during the 2009 survey.

Twenty-nine bird species were recorded opportunistically during the survey (Table 22). Eleven of these species were not recorded at any of the Beverley or Control trapping sites. The additional species included White-necked heron (*Ardea pacifica*), Rufous Songlark (*Cinchoramphus mathewsi*) and Tawny Frogmouth (*Podargus strigoides*).

Table 22. Bird species recorded opportunistically during the 2009 Beverley fauna monitoring.

Species Name	Common Name
<i>Accipiter fasciatus</i>	Brown Goshawk
<i>Anthus novaeseelandiae</i>	Richard's Pipit
<i>Aquila audax</i>	Wedge-tailed Eagle
<i>Ardea pacifica</i>	White-necked Heron
<i>Artamus cinereus</i>	Black-faced Woodswallow
<i>Barnardius zonarius</i>	Australian Ringneck
<i>Cacatua roseicapilla</i>	Galah
<i>Chenonetta jubata</i>	Australian Wood Duck
<i>Cinchoramphus mathewsi</i>	Rufous Songlark
<i>Cinchoroma cinnamomeum</i>	Cinnamon Quail-thrush
<i>Cygnus atratus</i>	Black Swan
<i>Epthianura tricolor</i>	Crimson Chat

Species Name	Common Name
<i>Eurostopodus argus</i>	Spotted Nightjar
<i>Falco berigora</i>	Brown Falcon
<i>Falco cenchroides</i>	Nankeen Kestrel
<i>Geopelia cuneata</i>	Diamond Dove
<i>Grallina cyanoleuca</i>	Magpie-lark
<i>Gymnorhina tibicen</i>	Australian Magpie
<i>Hirundo neoxena</i>	Welcome Swallow
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater
<i>Lichenostomus virescens</i>	Singing Honeyeater
<i>Melopsittacus undulatus</i>	Budgerigar
<i>Merops ornatus</i>	Rainbow Bee-eater
<i>Phaps chalcoptera</i>	Common Bronzewing
<i>Rhipidura leucophrys</i>	Willie Wagtail
<i>Podargus strigoides</i>	Tawny Frogmouth
<i>Psephotus varius</i>	Mulga Parrot
<i>Taeniopygia guttata</i>	Zebra Finch
<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher



Figure 37. Wedge-tailed Eagle Chick in a nest located north of site BU13.

4.0 Discussion

4.1 Survey Limitations

The presence of fauna species (particularly that of birds) will vary seasonally and in response to environmental conditions, consequently not all species that are known to or that are likely to occur within the project area would have been detected during the fauna monitoring project. However, the number of sites and survey effort are the same across the Beverley sites when compared to the 2007 and 2008 surveys whilst the same Control sites were used as 2008. The addition of the two Control sites within a Major Creekline habitat type will add to the strength of the data analysis and interpretation.

Weather conditions during the 2009 fauna monitoring surveys were considered to be quite good for detecting faunal species. A small amount (<3mm) of rain was recorded during the survey, however, the 10 months prior to the survey were extremely dry (<23mm rainfall in total).

The project area has had little annual rainfall over the past five years and the general health of the vegetation in the area is poor. The gibber plains contain very little vegetation cover and a number of Red Gums along Four Mile Creek are showing signs of water stress. The ongoing dry period is considered to be influencing the results of the fauna surveys at Beverley and may be a compounding factor in changes in abundance and diversity detected year to year. The changes associated with environmental conditions should be consistent between Control and Beverley sites and if reductions in abundance and diversity, caused by the environmental conditions, are recorded, this should occur across all sites.

4.2 Mammals

The 2009 survey of the Beverley Mine sites recorded a similar diversity and abundance of mammals as 2008 and significantly less than 2007. Very few rodents were recorded with no House Mice (*Mus musculus*), Forrest's Mouse (*Leggadina forresti*) or Sandy inland Mice (*Pseudomys hermannsbergensis*) recorded in 2009. The lower abundance was also partly due to the lower capture rates of Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Striped-faced Dunnart (*Sminthopsis macroura*). In 2007 36 Fat-tailed Dunnarts were recorded whilst in 2009 only 17 were recorded, the Striped-faced Dunnart had 21 captures in 2007 and 2009 there were only three captures of this species. For House Mice, 25 were captured in 2007 and none captured in 2009.

Two Dusky Hopping Mice (*Notomys fuscus*) were caught in 2009, one at site BU12 and one at BEXT05. The Dusky Hopping Mouse is rated as nationally **vulnerable** under the *EPBC Act 1999*. This species was previously caught for the first time in 2007; however, only males were caught. Waudby and How (2007) suggested that the population of Dusky Hopping Mouse is ephemeral and will not be able to maintain a stable population at Beverley because of the lack of suitable habitat and other environmental conditions. The fact that the species has been caught in 2008 and 2009 and that at least one breeding female (D. Hunt pers. comm.) has been caught, suggests that the species may have established a breeding population within the Beverley area. This population should be monitored to observe how long the species can persist in an area that is considered to be unsuitable habitat.

All of the bat species recorded on the Anabat detectors in 2009 are known to occur in the area. Generally, bat species were recorded at fewer sites in 2009 compared to other years. This suggests that the bats may not be travelling as widely as previous years or there are less bats within the area.

The relative abundance and relative diversity of ground-dwelling mammal species varies between years. In 2009 a similar relative diversity and relative abundance to the 2008 survey was recorded. There was a strong correlation between rainfall and the relative abundance and relative diversity of ground-dwelling fauna. This indicates that the amount of rainfall received within a calendar year can have a substantial impact on the number and diversity of ground-dwelling mammals.

A comparison between the Control sites and the Beverley sites indicates that there was no significant difference in the abundance or diversity between the two groups of sites. Both groups of sites had ten mammal species detected although the Beverley sites had higher mammal abundance with 64 individuals recorded compared to 41 at the Control sites. The species composition did vary with two species recorded at the Control sites (House Mouse and Forrest's Mouse) not detected at the Beverley sites and two species at the Beverley sites (Dusky Hopping Mouse and Inland Forest Bat) not detected at the Control sites.

4.3 Reptiles and Amphibians

The total diversity of reptile species, recorded at the Beverley Mine sites, in 2009 (16 species) was similar to 2008 (12 species) but less than 2007 (23 species). There was a significant difference in reptile diversity at the Beverley sites when compared across the three years where the data collection has been consistent. This indicates that whilst the overall diversity for all sites was higher in 2007, there was generally a higher diversity at each individual site as well. Although the abundance of reptiles was higher in 2007 (89 individuals) compared to 2008 (48 individuals) and 2009 (55 individuals), the differences observed were not significant.

The Control sites and Beverley Mine sites had a similar number of species recorded during the 2009 survey with 14 and 16 species recorded, respectively. The abundance of reptile species was also similar with 51 individuals recorded at the Control sites and 55 individuals recorded at the Beverley sites. However, there are two more trapping sites within the Beverley sites compared to the Control sites and therefore, on average the Control sites have a slightly higher abundance and diversity.

The diversity and abundance of reptiles, when considering data from the Beverley and Control sites, was higher at the Major Creekline sites compared to the Minor Drainage Line and Gibber sites. The Gibber sites offer suitable habitat to a limited number of species in the region. The lack of cover and refuge opportunities within the habitat type are considered to be the main reasons the Gibber sites are less diverse.

No amphibian species were recorded in 2009, primarily due to the dry survey conditions and the lack of pre-survey rainfall. The 2009 annual fauna survey had a higher relative abundance and relative diversity for reptile species compared to 2008, however, it was lower than the majority of other years where the annual survey has been undertaken. The correlation between reptile abundance and diversity and rainfall is slightly positive but it does not appear to be all that strong based on the current data. This may be due to reptiles responding to environmental conditions more slowly than birds and mammals which are either highly mobile (and can therefore move into areas providing greater resources) or can respond very quickly to resource changes (particularly dasyurids and rodents).

4.4 Birds

A higher diversity and greater abundance of birds was recorded, at the Beverley sites, in 2007 compared to 2008 and 2009. The abundance of birds at the Beverley sites was similar in 2008 and 2009; however, a higher abundance was recorded in 2007.

A higher diversity and abundance of bird species were recorded at the Beverley sites compared to the Control sites. Four more species were recorded at the Beverley sites and 111 more individuals. Part of the difference in the raw numbers is attributable to the ten Beverley sites being surveyed compared to the eight Control sites. As expected the Major Creekline sites had the highest diversity and abundance of birds compared to the Minor Drainage Line and Gibber sites. The Major Creeklines provide a broader range of habitats for birds and therefore can be utilised by a higher number of species.

The relative abundance and relative diversity of bird species follow a similar trend, to each other, with 2008 had the lowest abundance and diversity of all surveys and 2004 having the

highest. There was a slight increase in both abundance and diversity in 2009 and the abundance and diversity of birds appears to be more stable in recent years. This may be due to the extended period of dry conditions with the consistent conditions creating more stable populations in the area. The correlation between rainfall and abundance and diversity of birds suggests that a high rainfall year will bring an influx of species and individuals to the area.

5.0 Recommendations

The following recommendations have been made to ensure the annual fauna monitoring within the Beverley Mine project area is valuable:

- Ensure trap effort and methodology is consistent between sampling events and between the different sites;
- Monitor the population of the Dusky Hopping Mice to determine if the population is persisting;
- Maintain and utilise the existing summary table for small mammals, reptiles and birds.

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7.0 Appendices

Appendix 1 Site photos



BEXT02 Line A



BEXT02 Line B



BEXT03 Line A



BEXT03 Line B



BEXT04 Line A



BEXT04 Line B



BEXT05 Line A



BEXT05 Line B



BU11 Line A



BU11 Line B



BU12 Line A



BU12 Line B



BU13 Line A



BU13 Line B



BU14 Line A



BU14 Line B



BU15 Line A



BU15 Line B



BU16 Line A



BU16 Line B



CON01 Line A



CON01 Line B



CON02 Line A



CON02 Line B



CON03 Line A



CON03 Line B



CON04 Line A



CON04 Line B



CON05 Line A



CON05 Line B



CON06 Line A



CON06 Line B





CON07 Line A



CON07 Line B



CON08 Line A



CON08 Line B

APPENDIX H: Internal Audit Report

Document Number	Date Issued	Authorised by	Page No.
Bev-Report.131	31 March 2009	P Woods	120 of 120

Internal Compliance Audit for year 2009

- Documents: MARP Sept 2008
 Mining Lease 6321
 EPA Licence 12918

Audit date: January –March 2010

Auditors: Ping Goodwin, David Hunt, Sue Carter

Scope: To determine whether the requirements of the MARP, Mine Lease conditions and EPA licence have been completed

Distribution: Peter Woods

A = accept NCR = non compliance O = observation

Reference (standard, work instruction or document)	Question	A	NCR	O	Comments (include interviewees, observations etc)
MARP Sept 2008, 6.2.7, 6.2.8	Has there been leakage from double-lined ponds? How does this compare to the Target Action Leakage Rate (TALR) of 22 mL/m²/day?	A		O O	- Under pond liners for Ponds 1 to 4 are generally checked weekly using the 'pole method'. (Weekly checklist BEV FORM-290 sighted, (P. Omizollo). No leaks detected – this isn't clear on the records if leaks are actually detected. - Leaks from PLP and Pond 5 are electronically hardwired to the Control room, where alarms are displayed on the control system – no leaks have been detected in 2009 (P Coulthard). Alarms sighted on monitor in control room. - In 2007, records indicate that pumped volumes of any leaks were recorded, however this has not continued into 2009.
MARP Sept 2008, 6.2.7, 6.2.8	Are water levels in ponds: 1) checked at least weekly, 2) checked after >10 mm of rainfall in a day, and 3) maintained at least 0.20 m below lowest level of rim?	A A A			- Manual level check for Ponds 1-4 daily performed. Levels for Pond 5 and PLP are electronically recorded to control room and if the high water level alarm is triggered, all pumps to PLP and Pond 5 shut down (P. Coulthard). Visual checks also made. Records sighted on production database from daily midnight checks for each pond (P. Omizollo). - If ponds are nearing full, adjustments are made to send liquid to alternative ponds. There is no actual indicator at 20cm below lowest rim level (K. McMutrie).

MARP Sept 2008, 6.2.7, 6.2.8	Are any leaks detected by automatic systems or visual observation 1) logged as events, and 2) rectified?	A		O O	- Electronic leak detectors for Pond 5 and PLP are present and initiate inspections by staff, however these are not logged as events on the operating system (verbal P. Coulthard) - A leak was detected in Pond 4, and the liner was replaced in 2009 (verbal, K. McMutrie, P. Coulthard). - BEV-Form 290 shows that underpond liners have been checked, however it is not clear if leaks are found as each plant operator uses different symbols, language on the check sheets.
MARP Sept 2008, 6.2.7, 6.2.8	Is there documentation showing: 1) the number of spills, 2) the nature of spills 3) clean up actions?	A			All spills are documented in the <i>In Control</i> database, and include the date, nature and details of each spill, and remedial actions undertaken. These are then reviewed by the site manager/delegate prior to closure during the Operations/Safety meeting.
MARP Sept 2008, 6.2.7, 6.2.8	Is the number of non-compliant Environmental Clearance Permits (ECPs) involving off-road incidents documented? Are corrective actions in place to ensure these do not re-occur?	A A			All off-road incidents which are non compliant with the ECPs are reported to ESH Department. All reports/ sightings are now recorded on <i>In Control</i>. This was identified as an opportunity for improvement in the last compliance audit, and this has been achieved. Re-induction, fencing and/or signage implemented.

MARP Sept 2008, 6.2.7, 6.2.8	Are there surface sediment grab samples taken up and downstream of local creeks? Do the chemical parameters analysed include radionuclides? Are grab samples taken: 1) following rainfall events of >10 year ARI, 2) at least once per calendar year.	A N/A A		O	The same ten soils sediment sites have been sampled at least annually since 2003, however these do not cover the full extent of the ML after the expansion was granted in late 2008. Eight new sediment sites were sampled in January 2010, and have since been added to the sampling regime. Soil sediment sites were sampled in July 2009 and are analysed for Ra-226, Ra-228, U-232, Th-232, U-nat and Th-nat (Environment database sighted). The locations are both up and down stream of the plant. There were no rainfall events >10 year ARI in 2009 (weather station data).
MARP Sept 2008, 6.3.6, 6.3.7	Is all clearing undertaken approved in accordance to the MARP? Give 2 recent examples	A			Clearing of undisturbed areas is performed in accordance to the MARP. ECPs are completed prior to any work. Eg. ECP 0611 & 0587.
MARP Sept 2008, 6.3.6, 6.3.7; ML 6321 Sch2, 5.	Do the 1) fauna and 2) flora surveys show that there is no increase in feral animal or weed species in the Mine Lease areas when compared to pastoral areas?	A		O	Vegetation survey conducted in Sept 2009 (Badman Environmental). The recorded incidence of alien plants at the Beverley mine site is still about the same as at other similar areas in northern South Australia. Only one proclaimed plant species was recorded during the 2009 survey; this was <i>Tribulus terrestris</i> which was found to be common on the mine lease and in all surrounding areas. Fauna survey conducted in October 2009 (EBS Fauna Survey, Oct 2009). While there are alien/feral animals recorded at trapping sites and control sites (Tables 7, 9), these are not specifically compared within the report, and thus no conclusion can be drawn.

MARP Sept 2008, 6.3.6, 6.3.8; ML 6321 Sch2, 12.	Have any fires caused by mining operations been controlled within the ML boundary?	N/A			There were no fires in the open caused by mining operations.
	Is the extent of any fires mapped, showing area burned and distance from boundary?	N/A			Nil fires affecting the environment hence no mapping of fire extent was required.
MARP Sept 2008, 6.3.8, 6.6.6	Are control monitoring sites located approximately 5km from planned disturbance areas for 1) vegetation, and 2) fauna?	A A			All Control monitoring sites for vegetation and fauna are approximately 5km from planned disturbances (measured using Map Info).
	Were these sites chosen by a suitably qualified and experienced specialist?	A			All Control monitoring sites for vegetation and fauna monitoring were chosen by the qualified and experienced specialists.
	Have vegetation and fauna control sites been confirmed that there is no mineralisation?	A			Current maps also show that no known mineralisation occurs at the Control sites, (Map Info).
MARP Sept 2008, 6.3.8; ML 6321 Sch2, 4.	Is 1) species richness and 2) total cover for all plant species and perennials surveyed annually using 5m x 2m vegetation quadrats for the ML and local area?	A			Vegetation survey recording species richness and total cover for all plant species and perennials was performed in Sept 2009 by Badman Environmental. Sites within the ML and local area consisted of 5m x 2m quadrats
MARP Sept 2008, 6.3.8	Are weed 1) species and 2) cover surveyed annually using 4 x 1ha quadrats on the ML and local area?	A			4 sites (BU15, BE05, BE09 and BE16) were surveyed for weed species and cover in September 2009.
MARP Sept 2008, 6.3.8	Is there evidence showing that the number and density of alien vegetation species have been recorded following rainfall and during the Annual survey on the ML?	A		O	Caltrop spp. were observed in early 2009 in wellfields, camp and undeveloped areas, after significant rain in late 2008, however the density was not measured or recorded. There were other species found and confirmed by Badman Environmental (pers comm.) Annual vegetation survey has recorded the alien species density and number on field sheets.
MARP Sept 2008, 6.3.8	Is there an aerial photograph taken biannually (odd years) to assess vegetation changes on the ML?	A			The 2009 aerial photo was taken in March. File sighted on company computer system.

MARP Sept 2008, 6.3.8	Are there Environmental Clearances issued to document planned disturbances on ML? Is the actual disturbance on the ML at the end of each calendar year 1) Measured by GPS? 2) Reported as Percent Actual vs Expected Disturbance area	A A ?			All planned disturbances are issued with an ECP prior to commencement of any work on previously undisturbed areas. GPS of areas completed: • Dragon Wellfields DG01, DG02 • S8 Wellfield • Trunklines to Deep South and Bev East • Storage areas surrounding E&D camp • Carpark Extension at Plant • Four Mile Contractors Camp • Stores shed & unloading compound; Core cutting area for E&D • Loggers Yard and Shed • LLWD13 and LLWD14 • GW dumps.
MARP Sept 2008, 6.3.8	Ecosystem Function Analysis transects for controlled and disturbed areas within the ML and local areas established?	A			Yes, these are fenced and sign posted to prevent disturbance.
MARP Sept 2008, 6.3.8	Is there a measure of: 1) soil stability, 2) water infiltration and 3) nutrient recycling by determination of: • geographic setting of site; • landscape organisation and • soil surface assessment (rain splash protection, perennial vegetation cover, litter, cryptogram cover, crust brokenness, soil erosion, deposited materials, surface roughness, surface nature, slake test, texture)	A			Yes, these parameters are measured, as per Methods listed in Appendix A Table 1 from Annual EFA report Feb 2010.

MARP Sept 2008, 6.3.8	Are the following measured annually: 1) Plant cover, 2) density and 3) diversity using 'Point centred quarter' – sampling points established on EFA transect at regular intervals – at each point distance to nearest perennial plant in each of four sectors measured?	A			Yes. Method used is listed in Appendix A page 57 (EFA Annual Report Feb 2010).
MARP Sept 2008, 6.3.8	Is the upper-storey cover and density in areas with plants over 3 m in height measured annually using the 'Wandering Quarter' method – in areas with plants over 3 m in height - measuring 25 plants over 3 m in height within a 90 ° arc starting at the 0 m post of EFA transect?	A			One site, EFA09 recorded plants over 3m (Appendix e (a)). While the actual wandering quarter method is not described in the methods section, it appears to have been applied to 'cover' measurements in the results section for EFA09 (pg 19, EFA Annual report, Feb 2010). EFA consultants suggested the removal of the wandering quarter as there is insufficient vegetation over 3m to apply this method accurately or to apply this method to vegetation that is over 2m in height to get a statistically valid sample.
MARP Sept 2008, 6.4.8; ML 6321 Sch2, 6.	Were surface grab samples taken from North and South Mulga dams immediately after rainfall if creeks were flowing coinciding with a mining or disposal solution spill? Are these analysed for pH, EC, SO4 and U? There is no compromise of downstream surface water bodies? If these results are higher than the ANZECC/ARMCANZ 2000 guidelines listed below, has a mass balance been performed to determine if this is directly attributed to mining operations or due to natural variability? • Salinity (EC) < 4000mg/L or (6000uS/cm) • Sulphate < 1000 mg/L • Uranium < 0.2 mg/L	A A A A			No event of this type occurred, however, baseline samples of the dams were taken one week after a rain event in November 09 Samples were sent to ALS for analysis, and included these analytes, (report EM0912940). It appears that there is no compromise of these downstream water bodies. All analyses are lower than the ANZECC/ARMCANZ 2000 guidelines listed.

MARP Sept 2008, 6.5.6, 6.5.7, 6.5.8; ML 6321 Sch2, 7	Volume of GAB does not exceed the allocated volume specified by DWLBC licence conditions	N/A			There is no allocated volume set by regulators currently. Heathgate are in correspondence with regulators to set a volume of 140ML per annum (sighted letters from R. Phillips 9/12/09, and response from DWLBC dated 23/12/09).
MARP Sept 2008, 6.5.6, 6.5.7, 6.5.8; ML 6321 Sch2, 7.	Does the GAB pressure remain higher than the maximum Namba aquifer? Are there any trending pressure drops for GAB?	A A			GAB pressures are monitored monthly (pressures sighted on Environment Database), and remain above the ground surface. Namba water levels are managed so they remain at least 10m below the ground surface. Thus GAB pressures remain higher than the Namba aquifer, and no trending pressure drops have been identified.
MARP Sept 2008, 6.5.6, 6.5.7, 6.5.8; ML 6321 Sch2, 8.	Is there no adverse effect as a result of mining, for the water levels, ECL parameters (pH, SO4, U3O8) and conductivity in the Willawortina when compared to the ANZECC/ARMCANZ 2000 categories of water use?	A			The chemistry of the Willawortina varies considerably across the ML, as seen by EC, pH, SO4 and uranium analysis (Enviro Database), and many exceed the ANZECC/ARMCANZ 2000 categories of water use upper limits – these are the baseline concentrations, and are not due to mining activities.
MARP Sept 2008, 6.5.6, 6.5.7	Are there appropriate records that show that the LLRW facilities are built to design?	A			Procedure RAD-23 sighted; verified by A Robjohns via email. ECP # 0571 sighted, GPS co-ordinates and photos during construction of the LLRW facilities have been sighted for LLW13 and LLW14 constructed in 2009.
MARP Sept 2008, 6.5.6, 6.5.7; ML 6321 Sch2, 2,3,8.	Does groundwater monitoring of the Willawortina show that there is no contamination from the LLRW facilities?	A			The dump monitor wells (DMW001, 2 & 4) immediately surrounding the LLW facilities are screened in the Willawortina. Sampling commenced in 2009. U-238 has been analysed from these monitor wells and remained with a result of zero. Ra 226 remains at low levels (Environment database).
MARP Sept 2008, 6.5.6, 6.5.7; ML 6321 Sch2, 9.	Does monitoring of groundwater pH, SO4 and U3O8 show that there is no migration of mining and disposal solutions outside the ML?	A			None of the regulatory wells outside the ML indicate that mining or disposal solution has migrated outside the ML (Environment database).
MARP Sept 2008, 6.5.8	Are all 'Type 1' monitor wells monitored for water level and chemistry fortnightly?	A			Yes
MARP Sept 2008, 6.5.8	Are all 'Type 2' monitor wells monitored for water level and chemistry fortnightly?	A			Type 1, 2, 3, 4 and Willawortina monitor wells have been sampled at the correct frequencies for level

MARP Sept 2008, 6.5.8	Are all 'Type 3' monitor wells monitored for water level and chemistry quarterly?	A			and/or chemistry (Quarterly reports to Regulators, results on Environment database).
MARP Sept 2008, 6.5.8	Are all 'Type 4' monitor wells monitored for water level quarterly?	A			As new monitor wells come on-line, these have been added to the existing sampling schedule (Monitor Well Status report, BEV-Form 14, BEV-Form-16).
MARP Sept 2008, 6.5.8	Are all Willawortina monitor wells measured for water level fortnightly, and sampled for ECL parameters and Conductivity at a quarterly frequency?	A			
MARP Sept 2008, 6.6.6	Is there no decrease in native vertebrates compared to local background?	A			There are no significant differences between mammal, reptile and bird numbers between trapping sites and the control sites (EBS Fauna survey Oct 2009, pgs 22, 40, 55).
MARP Sept 2008, 6.6.6	Is there no increase in feral animal vertebrates compared to local background?			O	Fauna survey conducted in October 2009. While there are alien/feral animals recorded at trapping sites and control sites (EBS Fauna Survey, Oct 2009 Tables 7, 9), these are not specifically compared within the report, and thus no conclusion can be drawn.
MARP Sept 2008, 6.6.6	Were any complaints from neighbours regarding feral animal control investigated and if so proven not to be from mining activities?	A			There have been no complaints regarding feral animals in 2009 from neighbours. The site is working actively with the local station owners to control feral animals as a region. Eg Bite Back forum in November 2009.
MARP Sept 2008, 6.6.8	Terrestrial mammal and reptile trapping program utilising a line of pitfall traps with nearby Elliot and cage traps; fauna identified, sexed, marked and released unless otherwise required by trapping permit (e.g. voucher specimens for SA Museum).	A		O	At each trapping site and control site, 2 transects of pitfall traps, Elliot traps and cage traps were used to capture fauna, followed by identification, marking and release. In addition funnel traps were used in 2009 at each site (EBS Fauna Survey 2009, pg 7, 8, 10).
	Undertaken at all fauna sites annually?	A			There are no records indicating the captured animals were sexed prior to release.
	Total species number and abundance at each site reported?	A			This has been done annually. Total species and abundance at each site is reported (pgs 19, 20, 21).

MARP Sept 2008, 6.6.8	Bird transect – walked traverse logging species and abundance. Undertaken at all fauna sites annually. Total species number and abundance at each site reported?	A A A			Bird species and abundance was recorded at all trapping sites and control sites (EBS Fauna Survey, Oct 2009, Tables 18, 19). This has been done annually. Monthly bird transects (3 sites) were completed by site Environmental staff (Environment database).
MARP Sept 2008, 6.6.8	Microchiropteran bat trapping - using harp trap each night of the survey is performed annually at site BU12 . Total species number and abundance at each site reported?	A A			Harp traps were used on 10th and 11th Oct 09 at site BU12. The harp trap was set at 6 other sites over a total of 9 nights throughout the survey period. Species and abundance were recorded (EBS Fauna Survey Oct 2009, pgs 15, 17).
MARP Sept 2008, 6.6.8	At North Mulga Dam the following is completed: 1) Anabat – record ultrasonic echolocation calls and send to specialist consultant for analysis. 2) Microchiropteran bat trapping – mist net set up on evenings when wind conditions allow 3) Total species number and abundance at site reported? 4) Is done for 3 nights during survey?	A A A		O	Anabat and mist nets used on one night only 19/10/09 at North Mulga Dam, although a total of 14 nights of Anabat recordings were taken at various other sites during the survey. Weather conditions were unsuitable for any further mist netting. (EBS Fauna Survey Oct 2009, pg 15, 17, 18). Species and abundance were recorded using the mist nets. Due to the nature of Anabat, which only allows species to be recorded, abundance numbers are not obtainable.
MARP Sept 2008, 6.6.8	Bird transects are logged monthly for species and abundance at : 1) Process ponds 2) Four Mile GAB wetland bore 3) Wellfield	A			Yes. Monthly, bird species and abundance is recorded at each of the three sites (Environment Database).
MARP Sept 2008, 6.6.8	At the process ponds, Anabat – record ultrasonic echolocation calls and send to specialist consultant for analysis is performed 3 evenings during the survey Total species number and abundance at each site reported?			O	While Anabat was done at each trapping and control site and at North Mulga Dam, it was not set up at the process ponds during the survey.

MARP Sept 2008, 6.6.8	Spotlighting traverse – night drive with spotlight randomly around site and local area roads recording number and species of animals annually.	A			Spotlighting was performed during the Annual Fauna Survey at random sites, as well as previously established spotlight routes (EBS Fauna Survey Oct 2009, pg 14).
MARP Sept 2008, 6.7.7, 6.7.8; ML 6321 Sch2, 3.	Have the radon decay products and uranium dust in the: 1) processing plant, 2) ponds and 3) accommodation camp areas remained below the investigation levels?	A			On one occasion each for plant, and for ponds, the radon decay products at the ponds rose above investigation levels, however the average levels remain low. At all other times, levels at the ponds, plant and camp remained below investigation levels (Environment Quarterly reports Section 8, Radiation Occupational Monitoring Program Quarterly reports sighted Table 2.1.1) Uranium dust at camp, plant and ponds remained below investigation levels (Environment Quarterly reports Section 8), Radiation Occupational Monitoring Program Quarterly reports sighted Tables 2.1.2, 2.1.3, 2.2.1)
MARP Sept 2008, 6.7.8; ML 6321 Sch2, 3.	Are monitored doses of uranium dust and radon decay products calculated and within applicable limits as defined under the RPC Act 1982?	A			Doses for personnel monitoring are below investigation levels for dust (LLAA) and radon daughters (RnD) (Radiation Occupational Monitoring Program Quarterly reports, sighted Fig 3.1.2)
MARP Sept 2008, 6.8.8, 6.8.6	Has the map showing all identified sensitive areas been updated after every clearance survey? Is there documentation of the Aboriginal Heritage Clearances for all operational areas?	A			Yes, clearance areas are updated after each Heritage Survey by the company's cartographer (email J Barnes). Reports sighted with R Johnson. After each survey, the Anthropologist compiles a report, summarising the findings. In 2009, there were 3 Heritage clearances, but none were on the current Mine Lease (email J. Barnes). Reports sighted for operational areas from years prior to 2009 (Arkaroola/Wooltana).
MARP Sept 2008, 6.8.8, 6.8.6; ML 6321 Sch2, 11.	Are flagged areas checked for disturbance six-monthly, and after any relevant incident report?	A			One fenced Aboriginal site near Four Mile Creek crossing was examined in June and December 2009, and remained undisturbed. The other fenced areas are opportunistically checked, and appear to have not been disturbed in 2009 (sighted P. Goodwin).

MARP Sept 2008, 6.10	Does the Beverley Advisory Committee meet quarterly in Adelaide, Port Augusta and Beverley Site for the dissemination of information and for the Aboriginal community to raise issues?				The BACC meetings for 2009 were held as follows: 3 April in Adelaide office, 9 July and 5 November at Beverley and 15 December at Arkaroola (email R. Otte).
MARP Sept 2008, 6.10	Are Aboriginal Heritage Clearances with Native Title Claimants completed as part of the ongoing exploration and mine development program?	A			Yes and after each survey, the Anthropologist compiles a report, summarising the findings. In 2009, there were 2 Heritage clearances - Mt Yerila and Petermorra and Paralana and Arkaroola exploration licences. (email J. Barnes, reports sighted in E&D office, R Johnson)
MARP Sept 2008, 6.10	Is there an annual NAIDOC Day celebration at Beverley where Adnyamathanha and non-Adnyamathanha staff can interact with visiting Adnyamathanha people and to discuss any issues relating to the mine?	A			Yes, held on 9 th July 2009 (email A. White).
MARP Sept 2008, 6.10	Does the Beverley Environmental Consultative Committee (BECC) meet 6 monthly?	A			Yes, meetings held on 4 June and 5 November 2009 (email P Woods)
MARP Sept 2008, 6.10	Does the ISR Radiation Review Committee meet quarterly?	A			Yes, meetings held on 26 th March and 10 th September (email P Woods). The other two quarterly meetings were incorporated into BECC meetings on 4 th June and 5 th November as proposed by EPA (sighted email Cameron Jeffries, EPA).
MARP Sept 2008, 6.10	Are there meetings with the pastoralist from Wooltana Station every two months to exchange information on mining and pastoral practices in the area			O	There are no formally scheduled meetings with Wooltana Station pastoralist. Frequent contact via visit or telephone when required occurs, and both sides have good relations.
MARP Sept 2008, 6.10	Are there ad-hoc meetings with nearby landholders to exchange information?	A			Yes, meetings with Petrathern, Arkaroola, Wertaloona (Bite Back); Leigh Creek Police visit for familiarisation, Wooltana manager had tour of site are examples (Community Consultation database).
MARP Sept 2008, 6.10	Are there ad-hoc meetings with the broader district?	A			Yes, Cultural training at Iga Warta, SA Museum visit, Arkaroola Wilderness Sanctuary owners visit, Friends of the Earth visit, ASNO visit (Community Consultation database)

MARP Sept 2008, 6.10	Has Heathgate informed the general public at least annually to keep the wider community informed?	A			Yes, MARCR was made available through PIRSA website (email P Woods): https://egate.pir.sa.gov.au/webbasis/WebtopE/ws/samref/env/image/DDD/Env11783_R200900156
Lease conditions for ML 6321, Table 8-1 p160	Has Heathgate undertaken an independent audit of achievement of the environmental outcomes in the MARP, by an independent expert approved by the Director of Mines? (This only needs to be done every 3 years) Has the audit been made available to the public, in a manner and form as determined by the Director of Mines?	N/A			An independent audit was undertaken in 2008 for years 2005-7. The next scheduled independent audit is not due until 2011 for years 2008-10.
Lease conditions for ML 6321, Table 8-1 p167	Has the independent audit of compliance report been submitted to the Minister? Has the independent auditor been approved by the Minister prior to the commencement of the audit? Has the audit criteria been agreed to by the Minister? Has the audit report addressed the criteria to the satisfaction of the Minister?	N/A			
Lease conditions for ML 6321, Table 8-1 p167	Has Heathgate maintained accurate records substantiating all activities associated with or relevant to the above conditions of approval and made them available upon request to the Department?	A			All environmental monitoring records are retained within the ESH office; Incidents are recorded on the In Control database; Aboriginal Heritage clearances are kept by the E&D department, and hard copies with the Aboriginal Liaison Officers. Record keeping is ongoing.
ML 6321 Sch2, 10.	Can it be shown that there were no adverse impacts from mining on native fauna abundance or diversity on the ML and adjacent areas?	A			There appears to be no impact from mining on the native fauna species and abundance compared to adjacent areas (Annual Fauna survey, Oct 2009).

ML 6321 Sch2, 5	Has Heathgate made all reasonable attempts to ensure there are no injuries or deaths as a result from unauthorised entry to the site?	A			Large amounts of fencing have been completed in 2009 to prevent unauthorised entry from the main public road. Signs and security gates are present, as well as a security camera at the entrance. Other entrances to site are sign posted.
EPA Licence 12918 (330-201)	Are all chemicals, oils and lubricants : 1. Clearly labelled 2. Stored in accordance with 'EPA Guideline for Bunding and spill Management, Sept 2007'?			O O	• Labelling inside the plant chemical storage areas are clear, and designated cupboards for hazardous materials are in place. Bulk, portable hazardous chemicals are stored in clearly labelled tanks. The bulk and day tanks for storage of caustic, sulphuric acid and peroxide are all labelled clearly, as are the tanks under construction for these bulk materials. Laydown diesel tank is clearly labelled. The camp diesel tank is not labelled, although padlocked and rarely used (sighted P. Goodwin 3/2/10). • The NEW caustic, sulphuric acid and peroxides are bunded separately and capacity appears compliant with EPA Guidelines 2007(email S.Pearce 2/3/10, drawings IP6324-001-C001-001 sheet 1 and 2).
EPA Licence 12918 (67-1209)	Is only non-radioactive waste produced from mining operations disposed within the landfill waste dumps?	A			All waste disposed into sanitary waste dumps are radiation scanned prior to disposal and burial. Inductions clearly inform site workers how to dispose of non-radioactive and contaminated wastes, and separate bins are distributed around the plant, offices and wellfields.
EPA Licence 12918 (67-1210)	Are the: 1. dimensions of the landfill waste facilities, and 2. rehabilitation measures in accordance with the document 'Technical Report in Support of Application for Amendment: Addition of Waste Facility, June 2009'?	A A			Yes. General waste dumps are pegged by a site Supervisor. GPS co-ordinates are obtained for the boundaries, and construction is performed in accordance with the Environmental Clearance Permit issued prior to any disturbance of the soil. Eg. ECP 0581 FMJV General Waste dump. Closure and monitoring of full general waste dumps is completed as required. However, once the excavated material is returned and topsoil spread and scarified, the surface is not fenced off to prevent further disturbance. Often this space is used for general storage.

EPA Licence 12918 (67-1211)	Has a report been submitted to the EPA by Sept 1st for the preceding financial year? Does it include: • Volume of leachate generated from landfill cells? • Disposal methods for the leachate? • Remaining capacity for the current disposal cell? • Details of rehabilitation work carried out on closed cells?	N/A			• The first report is not due until Sept 2010 for the period July 2009 to June 2010. • Measurement of leachate volumes and disposal details has been incorporated into the current monthly monitoring program for dump bailers. • When each cell is closed, the topsoil is scarified to assist rehabilitation. However, in the past the land has been used for storage of equipment and goods, and has not been allowed to rehabilitate.
EPA Licence 12918 (67-563)	Is there a register of all LISTED wastes received and disposed of at the landfill? Does it detail: • The type of waste received and disposed? • Date of receipt of waste? • Date of disposal of waste? • Volume of each waste type?			O	The need to record listed wastes as required per EPA licence was highlighted at a Supervisor's meeting once the licence was approved in Sept 2009, however this is yet to be actioned.
EPA Licence 12918 (67-687)	Has there been a fire on the premises? If so, • Has the EPA been notified within 2 hours of becoming aware? • Provide a written report to EPA within 72 hours, which includes the date of fire, time, cause (if known), the area (location) of the fire, and any preventative measures implemented.	N/A			Nil fires have occurred in the waste facilities.
EPA Licence 12918 (67-688)	Are measures in place to prevent escape of litter from the active disposal area? Is escaped litter collected and disposed of each day?	A			• General waste is covered with soil daily, so escape of litter is minimal to zero. • Any escaped litter can be trapped by the security fencing surrounding the active cell, and regular rubbish collections around site are performed when required.

EPA Licence 12918 (67-691)	At the end of each days' operation, is no less than 150mm of waste fill used to cover landfill?	A			Yes, this does happen. (Site inspection on 16/1/10). No litter was seen exposed in the active cell.
EPA Licence 12918 (67-691)	Are there measures to prevent the ingress of stormwater into the active disposal cell?	A			Rainfall at the site is minimal, and ingress of stormwater into the active cell is minimal.
EPA Licence 12918 (67-697)	Are measures in place to prevent the escape of odour?	A			The site does not appear to have any issue with the release of odour from the site. It also does not have close neighbours, due to its remote location.
EPA Licence 12918 (67-697)	Waste previously disposed of is not removed or exposed?	A			Buried waste is not removed or exposed.
EPA Licence 12918 (67-700)	Is there a fence that prevents unauthorised access to the Premises?	A			The current ML is not entirely fenced. Fencing of the boundary near the main public access road is completed, as well as security gate and camera at the main entrance. Secure fencing also exists around the plant, the packing areas and the sanitary waste dumps. Due to the remoteness of the site fencing measures are reasonable to prevent unauthorised access to the site.
EPA Licence 12918 (67-702)	Is the receipt and disposal of waste supervised in accordance with this EPA licence?			O	Only one condition of this licence is not currently in place, as this refers to the recording of the date and amounts of listed waste disposed in the sanitary waste dumps, identified in this audit.
EPA Licence 12918 (400-215)	Are all site personnel responsible for carrying out tasks controlled by this licence properly advised on their duty of care?	A			All site personnel are advised of their duty of care in the induction/re-induction, and inductions are signed be each person prior to commencement of work.
EPA Licence 12918 (400-78)	Has the annual authorisation fee been paid by the due date?	A			
EPA Licence 12918 (400-79)	Has an annual return been submitted 90 days before the authorisation fee payment date?	NCR			The Annual Return was submitted late (7 October 09).
EPA Licence 12918 (400-79)	Has an application for renewal of licence been completed at least 90 days before the expiry date?	N/A			Licence expires on 31 October 2010:

EPA Licence 12918 (400-339)	Is a copy of this licence displayed on a noticeboard at site?	A			The licence is on the notice board in reception. (sighted P Goodwin, 16/1/10).
Internal Compliance Audit for year 2008	Measure and record the actual area disturbed for sites granted ECPs.	A			Yes. Map Info data sighted for 2008, D. Hunt.
Internal Compliance Audit for year 2008	An update of the current Bev-Form 115 is required to record more detailed information for leakage checking at the double lines ponds. Provision needs to be made for recording liquid volumes if moisture detected, whether a leak was detected, and any corrective actions undertaken.			O	This was not performed.
Internal Compliance Audit for year 2008	All non-compliant off road disturbances should be documented and corrective measures implemented.	A			All non-compliant off road disturbances noticed are documented and corrective actions undertaken
Internal Compliance Audit for year 2008	Improve the communication with contractors that conduct surveys on behalf of Heathgate, so they are fully aware of our regulatory requirements with regards to monitoring and reporting. In particular: • Correct use of the Wandering Quarter method in EFA monitoring, • Comparison of feral animals between mining and control sites, • Sexing of fauna identified in the annual survey, • Use of mist netting and Anabat for 3 nights at North Mulga Dam, and Process Ponds, • Establish 3 more 1ha vegetation quadrats prior or during the 2009 flora survey, • Establish control sites in the major ephemeral creeklines for fauna monitoring prior or during the 2009 fauna survey.			O	Many of these issues have been addressed although a few of these items have still not been actioned in the 2009 annual surveys.

Internal Compliance Audit for year 2008	Conduct searches and record weed species after rains.			O	Few weeds occur on site (Badman Environmental Reports) weeds that are noticed are pulled or sprayed immediately. Exception being <i>Tribulus Spp</i> (Caltrop), which can be in excessive numbers throughout the region, this is sprayed only around the camp.
Internal Compliance Audit for year 2008	Create a single map showing all areas identified during Heritage Surveys, and ensure future identified areas are also updated.	A			This was achieved, and is located on file in the Adelaide office by the company's cartographer.
Internal Compliance Audit for year 2008	Establish a checking regime for all areas identified during Heritage Surveys, to ensure these remain undisturbed and follow up any relevant incident reporting and corrective actions when required.	A			The identified grave within the ML has not been disturbed in June and Dec 09 inspections. Fencing is still intact.
Internal Compliance Audit for year 2008	Maintain regular contact/meetings with Wooltana Station pastoralist, and ensure these are recorded on the community consultation database.			O	There are no formalised planned meetings with the Wooltana Station pastoralist, however there is an open two way line of communication.
Internal Compliance Audit for year 2008	Transfer handwritten results from monthly bird transects into the electronic Environmental Database.	A			This has been ongoing, and is nearly completed.
Out of scope observation					Animal register has been transferred from handwritten results onto the electronic Environmental Database.

Audit summary

Commendations

- Much of the data and records used were easily and readily accessible.
- Many of the items requiring improvement from the audit 12 months earlier were completed or are in progress.
- The labelling of chemicals on site is reasonably good.

Areas requiring improvement

- The use of Bev Form 290 shows that underpond liners have been checked, however it needs to be standardised to ensure that checks done by plant operators are consistent. For example, while the actual checks are performed, it is not clear if leaks are actually found, as each plant operator uses different symbols, language on the checksheet. Also, the automated alarms that appear in the control room for PLP and Pond 5 are not logged as events in any work sheet – perhaps this could be incorporated into an existing form, as well as any corrective actions/outcomes from the checks.
- An update of the current Bev-Form 115 was recommended in an audit 12 months earlier to record more detailed information for leakage checking at the double lined ponds. Provision needs to be made for recording liquid volumes if moisture detected, whether a leak was detected, and any corrective actions undertaken.
- In 2007, records indicate that pumped volumes of any leaks were recorded, however this has not continued into 2009. It is suggested that volumes of liquid pumped out from under the pond liners are recorded, so it can be compared to the Target Action Leakage Rate (TALR) of 22 mL/m²/day. It is suggested to also update procedure ENV-001 – Under Pond Liner and any associated working documents to ensure the requirements are completed. This was identified in a similar audit 12 months earlier,
- Ensure that the eight new sediment sites are added to the sampling regime for 2010.
- Further improvement on the communication with contractors that conduct surveys on behalf of Heathgate is still required, to ensure they are fully aware of our regulatory requirements with regards to monitoring and reporting. Some requirements were identified in an audit 12 months ago, and still remain unaddressed. The Annual Fauna Survey Report for 2009 do not completely address several requirements:
 - While data was collected, no specific comparison and conclusion was made regarding the impact of mining on the numbers of feral animals compared to surrounding areas,
 - Captured animals were not sexed prior to release,
 - Anabat was required to be used for three nights at each of North Mulga Dam and Process Ponds locations. It was only used to record bat species on one night at North Mulga Dam, and was not used at the Process Ponds.
- Formalise a record sheet or database location for opportunistic observations of weed species that are sighted, for species and density after rains.
- Formalise regular visits with Wooltana Station pastoralist, as per requirements. This was identified in an audit 12 months ago, however it is recognised that the communication between both is regular and cooperative.
- The need to record listed wastes as required per EPA licence was highlighted at a Supervisors' meeting once the licence was approved in Sept 2009, however no further action was implemented. A system to record the type, date of receipt and disposal of waste, and volume of each listed waste type needs to be developed. The Annual report to EPA is due in Sept 2010, and it recommended that this is in place by this date.
- The diesel tank at camp is not labelled clearly.

Out of scope observations

The complete transfer of the handwritten Animal Register onto the site's Environmental database has been completed.