360 environmental

Beatons Creek Paleoplacer Gold Project: M46/9, M46/10, M46/11 and M46/532

Application for a Native Vegetation Clearing Permit Amendment – Purpose Permit (CPS 7440/2)

Prepared for:

Beatons Creek Gold Pty Ltd

November 2019

people planet professional

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1 Introduction

360 Environmental Pty Ltd (360 Environmental) was commissioned by Beatons Creek Gold Pty Ltd (BCG) to undertake a Native Vegetation Clearing Permit (NVCP) amendment application (Purpose Permit) for CPS 7440/2 as part of the approvals to facilitate the Beatons Creek Paleoplacer Gold Project (the Paleoplacer Project).

The Paleoplacer Project is located on Mining Tenements M46/9, M46/11, M46/10 and M46/532. The Paleoplacer Project is approximately 2 km to the north-west of the Nullagine Township in the Pilbara region of West Australia (Figures 1 and 2). The purpose of this document is to amend the currently approved clearing permit CPS 7440/2 boundary to include an additional 75 ha (3 ha on M46/9 and 72 ha on M46/11) (Figure 3). CPS 7440/2 supports the approved mining of 3 mtpa of the Oxide material zone at the Paleoplacer Project (Reg ID 71318). The amendment of CPS 7440/2 will support a proposed mining proposal to increase the production from 3 mtpa to 133 mtpa further into the Oxide and also into the Fresh material zone of the Project.

A Clearing Permit is required as the clearing is proposed to be undertaken within a Schedule 1 Area and the proposed clearing is more than 10 ha per annum per Mining Lease. The total amended clearing area being applied for is up to 75 ha (in addition to the approved 195 ha under CPS 7440/2). Therefore, the total clearing area being applied for is 270 ha. A Purpose Permit is being pursued as the exact alignment of access tracks and clearing boundaries around mineral resources will be determined when machinery reaches site.

Operational components of the Paleoplacer Project already have valid Purpose Permits (and mining approvals) in place:

- Bulk Sample Operations (CPS 6899/1);
- Alluvial Operations (CPS 7128/1); and
- Paleoplacer Project (Northern and Southern Operations) (CPS 7440/2).

A small scale Gravity Pilot Plant and associated sedimentation ponds and stockpiles, together with crib facilities were established on site in areas of existing disturbance and permitted under approved Mining Proposals Reg ID 58019 and Reg ID 59827. Reg ID 58019 also approves the excavation of material from the Bulk Sample Operations. Reg ID 71318 approves the mining of the Northern and Southern Operations.

This clearing permit application only discusses and assesses the proposed 75 ha which is in addition to the approved 195 ha under CPS 7440/2 (Figure 3).

1.1 Background

BCG is an Australian subsidiary company of Novo Resources Corporation (Novo). Novo is a Vancouver based mineral exploration company, listed on the Toronto Venture

Exchange (TSXV) in Canada. BCG is proposing to develop the Paleoplacer Project, which involves the development of a gold mine and associated infrastructure near Nullagine in the East Pilbara region of Western Australia.

The Environmental Protection Authority Services Unit (EPA), Department of Water and Environment Regulation (DWER) and Department of Mines, Industry Regulation and Safety (DMIRS) have been consulted as key regulators in the development of the Paleoplacer Project, including the operational components already approved. The EPA confirmed in November 2016 that, as the Paleoplacer Project does not propose on-site processing for the majority of the resource, referral under s38 would not be required and the proposal can be permitted via a Mining Proposal and NVCP.

The EPA had previously advised that referral was not required for the Bulk Sample, Alluvial and pilot-scale Gravity Processing Plant.

DWER (November 2016) also acknowledged that the change to remove the majority of processing from the scope of the Paleoplacer Project reduced the risk of contamination to the P1 PDSWA which had been their primary concern. No processing will occur on the proposed (amended) clearing area apart from the small gravity-only plant already approved under a Mining Proposal (REG ID 59827) and Registration (R2424/2016/1).

A meeting also in November 2016 confirmed that DMIRS was satisfied that the change to avoidance of Carbon in Leach (CIL) processing on site significantly reduces risk of the Paleoplacer Project. DMIRS has since approved the MPMCP for the Paleoplacer Project (Reg ID 71318).

1.2 Purpose of Document

The purpose of this document is to present the results of an assessment of the proposed (amended) clearing area against the ten clearing principles as outlined in the Department of Environment Regulation (DER) *Guide to Assessment: Clearing of Native Vegetation under the Environmental Protection Act 1986* (EP Act). This report identifies the potential environmental impacts associated with the clearing of the additional 75 ha of the Paleoplacer Project based on the best available data. This NVCP amendment application will be submitted to DMIRS as clearing is to be carried out on mining tenements.

1.3 Scope

For reasons of timing, BCG has split the Paleoplacer Project into several stages (Figure 2):

- Bulk Sample (approved NVCP 7440/2 and Mining Proposal Reg ID 58019);
- Alluvial Scraping Operations, Southern Operations and Northern Operations (approved NVCP 7440/2, and Mining Proposal/Mine Closure Plan REG ID 71318); and

- Future Operations (mining of Fresh material on M46/9, 10, 11 and 532; subject of this NVCP amendment and Mining Proposal in preparation).

This NVCP application includes the additional clearing of 75 ha for the Future Operations which will be an amendment to CPS 7440/2 (Figure 3).

1.4 Activities

BCG proposes to mine approximately 10 million tonnes of material per annum. This will occur over a ~15 year period from the resource within tenements M46/9, M46/10, M46/11 and M46/532. Ore will be processed offsite (toll treatment) at a location yet to be determined; BCG will not commence mining until all approvals for toll treatment have been obtained.

The mining of the Paleoplacer Project will involve mining discreet oxide reefs as seen in the eastern portion of the project area and will result in shallow, stable pits. The central and western portions of the project will be mined deeper into the fresh rock and covered over with a central Waste Rock Landform as seen in Figure 2. Only the south western portion of the project (Grants Hill) will be mined beneath the water table, where limited dewatering will be required during operations. This area has an existing approved clearing permit CPS7440/2 and will be managed under the MPMCP approvals with DMIRS. Topsoil will be collected and stockpiled. Ore will be stockpiled on site prior to transport to offsite.

Environmental management considerations for mining of the future area at Beaton's Creek Project will be described in more detail in an upcoming Mining Proposal for the Beatons Creek EGS.

An indicative clearing footprint (disturbance area) is shown in Figure 3.

1.5 Responsible Person

BCG is responsible for implementation of the clearing described within this document. Correspondence relating to this NVCP application should be addressed to:

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2 Site Overview

2.1 Description

2.1.1 Physical Setting

The geology surrounding the Beatons Creek area is considered to be of Paleoplacer origins, which are late Archaean to early Proterozoic in age. The mineralisation has been interpreted to have formed in a transgression, regression alluvial fan depositional environment, where the gold sediments were deposited approximately 2.7 billion years ago.

The Paleoplacer Project lies within an area of rugged topography and complex geomorphology. The Fortescue Group, which dominates the Paleoplacer Project, is generally well exposed with topography ranging from approximately 150 to 400 metres (m) thick and 400 and 550 m above sea-level (Tetra Tech 2013). The formations of the Fortescue Group can exist as high outcrops with steep, irregular, boulder-strewn hill slopes that give rise to smooth intervening, flat-bottomed valleys (Tetra Tech 2013).

The Paleoplacer Project occurs in the Capricorn and Mosquito land systems with the majority of the Project occurring in the Capricorn land system. Both land systems are widely distributed outside the proposed disturbance area of the Paleoplacer project. The Mosquito System is described as "stony plains and prominent ridges of schist and other metamorphic rocks supporting shrubby spinifex grasslands", while the Capricorn System is described as "rugged sandstone hills, ridges, stony footslopes and interfluves supporting low acacia shrublands or hard spinifex grasslands with scattered shrubs" (van Vreeswyk et al. 2004).

Soils within the Paleoplacer Project primarily consists of stony soils, with some areas containing red shallow loams and to a lesser extent, shallow red/brown non-cracking clays (Van Vreeswyk et al. 2004) (Figure 10).

2.1.2 Mineralisation

Mineralisation of Beatons Creek Paleoplacer Project is mainly located within several stratigraphic levels situated in the Fortescue Group. Gold is found within the matrix of several flat lying conglomerate reefs, up to two metres thick which are laterally extensive. Most of the gold occurs as fine grains, larger flakes and rounded particles several millimetres across within the matrix of these conglomerates. Geomorphology of the area includes prominent ridges up to 30 m high separated by incised valleys. The gold bearing reefs outcrop within these ridges.

2.2 Proposal Tenure

The tenure of the Paleoplacer project includes leases (pastoral), state land (reserve) and unallocated Crown land. The site is covered by an approved native title determination with the Njamal and Palkyu people. A Mining Agreement for the Paleoplacer Project with both parties is currently in place regarding potential impacts to the land use and heritage values.

The Paleoplacer Project is located on mining tenements M46/9, M46/10 and M46/11; and M46/532. The status and ownership of the tenements is presented in Table 1.

Table 1: Tenement Status

Tenement	Holder	Area (ha)	Date of Grant	Status
M46/9	Beatons Creek Gold Pty Ltd	248	26/02/1985	Live
M46/10[1]	Beatons Creek Gold Pty Ltd	121	07/12/1984	Live
M46/11	Beatons Creek Gold Pty Ltd	465	10/01/1985	Live
M46/532[1]	Grants Hill Gold Pty Ltd	134.58	05/08/2019	Live

[1] Excluded from this amended NVCP assessment, but included for context

3 Assessment Methodology

3.1 Desktop Assessment

An initial desktop assessment included a review of current and relevant literature sources, databases and GIS Information (constraints mapping) to determine:

- The possible impacts, environmental sensitivities and the environmental risk associated with the proposed clearing; and
- Whether the proposed clearing is exempt under the EP Act or the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (the Clearing Regulations).

Included in the desktop work was the assessment of the likely impacts to native vegetation clearing against the ten clearing principles applicable to the Permit, contained in the Clearing Regulations. The ten clearing principles are as follows:

- Principle (a) – Native vegetation should not be cleared if it comprises a high level of biological diversity;
- Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to Western Australia;
- Principle (c) – Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora;
- Principle (d) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a Threatened Ecological Community (TEC);
- Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared;
- Principle (f) – Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland;
- Principle (g) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation;
- Principle (h) – Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;
- Principle (i) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; and

- Principle (j) – Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

The desktop study provided background information on the flora and vegetation of the project area. Database searches, as described in Table 2, of the Department of Biodiversity Conservation and Attractions (DBCA) databases as well as the Department of the Environment and Energy (DEE) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) were undertaken to compile a list of expected Threatened or Priority species and TECs or Priority Ecological Communities (PECs) that may occur in the Project area.

Table 2: Database Searches Undertaken to Identify Potential Environmental Constraints

Potential Environmental Constraint(s)	Database Searches
Matters of National Environmental Significance (MNES)	• EPBC Act PMST, 50 km radial search (DEE 2015) • EPBC Act PMST, 20 km radial search (DEE 2019)
Threatened and Priority species	• Department of Parks and Wildlife (DPaW) Threatened and Priority Flora database, 50 km radial search (DPaW 2014a) • DPaW NatureMap Flora search, 40 km* radial search (DPaW 2014b) • DPaW Threatened and Priority Fauna information, 50 km radial search (DPaW 2014c) • DPaW NatureMap Fauna Search, 40 km* radial search (DPaW 2014d) • DBCA NatureMap Flora search, 20 km radial search (DBCA 2019)
TECs and / or PECs	• DPaW Threatened and Priority Ecological Community database, 50 km radial search (DPaW 2014e) • EPBC Act PMST, 50 km radial search (DEE 2015) • EPBC Act PMST, 20 km radial search (DEE 2019)

* For NatureMap, the maximum buffer allowed is 40 km.

The abovementioned databases were reviewed in October 2019 to update any information that may have changed in the intervening time from original surveys. The changes were as follows:

- DPaW is now the Department of Biodiversity Conservation and Attractions (DBCA);
- The State *Wildlife Conservation Act 1950* (WC Act) has been replaced by the *Biodiversity Conservation Act 2016* (BC Act);

- Ghost Bat: At the time of the fauna survey, *Macroderma gigas* (Ghost Bat) was listed as a Priority 4 species under the DBCA priority list. The Ghost Bat has since been listed under the BC Act and EPBC Act as Vulnerable. Desktop assessments determined the Ghost Bat is likely to occur in the area. During the fauna surveys, the Ghost Bat was not recorded and recorded roost sites were considered not to be suitable for the Ghost Bat. Further discussion of the species has been included in this document in Section 5;
- Rainbow Bee-eater: On 9 June 2016, *Merops ornatus* (Rainbow Bee-eater) was removed from the list of Migratory species under the EPBC Act. And has been delisted as Priority 4 under DBCA Priority species list. This species is not mentioned further in this document; and
- The following migratory bird species were returned in the 2019 PMST database search: Barn Swallow (MiTe[2]), Grey Wagtail (MiTe), Yellow Wagtail (MiTe), Common Sandpiper (MiWe[3]), Curlew Sandpiper (MiWe) and Pectoral Sandpiper (MiWe). There is no wetland habitat within the proposed clearing area, however the Nullagine Dam is located 1 km to the south east; the dam may be used for foraging habitat for the wetland species.

[2] Migratory Terrestrial under EPBC Act
[3] Migratory Wetland under EPBC Act

3.2 Field Surveys

Table 3 outlines the field surveys and baseline data collected for the Paleoplacer Project which have been undertaken to date.

Table 3: Summary of Environmental Studies and Surveys

Consultant/ Survey Name	Study Area, Type and Timing	Study Standard/ Guidance and Limitations	Appendix
Flora and Vegetation			
MMWC Environmental *Beatons Creek Gold Project Flora and Vegetation Assessment*	Paleoplacer development envelope (1,172 ha) Desktop review and field survey September 2014	EPA Guidance Statement No.51 Level 2 Survey Consultation with Department of Parks and Wildlife **Limitations:** No significant limitations noted	Appendix A
Terrestrial Fauna			
360 Environmental *Baseline Vertebrate Fauna Survey* *EPBC Act Protected Matters Report*	Paleoplacer development envelope (1,172 ha) Desktop review and field survey September and October 2014	EPA Guidance Statement No. 56 Level 2 vertebrate fauna survey **Limitations:** Access to some areas constrained	Appendix B
360 Environmental *Targeted Northern Quoll Survey*	Paleoplacer development envelope (1,172 ha) Desktop review and field survey April 2015	EPA Guidance Statement No. 56 Targeted Northern Quoll Survey **Limitations:** Access to some areas constrained	Appendix C

Consultant/ Survey Name	Study Area, Type and Timing	Study Standard/ Guidance and Limitations	Appendix
Bat Call WA *Targeted Pilbara Leaf-nosed Bat Survey*	Paleoplacer development envelope and beyond (1,172 ha) December 2014	EPA Guidance Statement No. 56 Targeted Pilbara Leaf-nosed Bat Survey **Limitations:** Access to some areas constrained	Appendix H of Appendix B
Terrestrial Environmental Quality			
SRK Consulting *Beatons Creek Oxide Material Acid and Metalliferous Drainage (AMD) Assessment*	Paleoplacer operations areas October 2015	Department of Industry Tourism and Resources (DITR), 2007: Managing Acid and Metalliferous Drainage. Leading Practice Sustainable Development Program for the Mining Industry. **Limitations:** There was limited data available to characterise materials to be mined at a greater depth than 20 m	Appendix D
Mine Earth *Soil and Sediment Letter Report November 2015*	Paleoplacer September 2015	Australian Standard (1993): Geotechnical Site Investigations (Including Amendments 1 and 2 – 1994). AS 1726-1993. Sydney, Australia **Limitations:** No significant limitations noted	Appendix E

Consultant/ Survey Name	Study Area, Type and Timing	Study Standard/ Guidance and Limitations	Appendix
Mine Earth *Waste Rock Characterisation Report December 2015*	Paleoplacer December 2015	**Limitations:** No significant limitations noted	Appendix F
Mine Earth *Assessment of the Physical Properties of Mine Waste for the Beatons Creek Project 2017*	Paleoplacer November 2017	**Limitations:** No significant limitations noted	Appendix G
Auralia Mining Consulting *Handling of Waste Material at Beatons Creek*	Paleoplacer January 2018	N/A – letter of advice, not results of a survey	Appendix H
SRK *H2 Hydrogeological Assessment; Beatons Creek Gold Project v3*	Paleoplacer August 2018	Operational policy no. 5.12 – Hydrogeological reporting associated with a groundwater well licence. Department of Water Assessment Level Criteria H2; Basic field hydrogeological assessment, including drilling and test pumping, is required. **Limitations:** No significant limitations noted	Appendix I

3.2.1 Level 2 Flora and Vegetation Assessment

MMWC was commissioned by Novo Resources in August 2014 to undertake a single season level 2 flora and vegetation assessment of the Beatons Creek Gold Project (Appendix A). The field survey was conducted over seven days, with 14 person-days invested in the field survey. The survey was consistent with a single season Level 2 flora and vegetation survey per EPA requirements for environmental surveying and reporting for flora and vegetation in Western Australia, as set out in the following documents:

- Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No.2 (EPA 2000);
- Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3 (EPA 2002); and
- EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51 (EPA 2004a).[4]

The field survey comprised a total of 1,172 ha (the survey area) and was undertaken from 2 September 2014 to 9 September 2014 by two appropriately experienced botanists. Objectives of the flora and vegetation assessment were to:

- Conduct a flora and vegetation database search and literature review;
- Undertake a field survey to assess the flora and vegetation within the survey area;
- Document, describe and map the vegetation associations present;
- Compile an inventory of vascular plant species present;
- Undertake targeted searches and map locations of Threatened and/or Priority flora;
- Record the occurrence of introduced plant species;
- Assess and map vegetation condition;
- Assess the potential impact of clearing on any significant vegetation or flora; and
- Assess the proposed development against the ten Native Vegetation Clearing Principles as detailed in Schedule 5.0 of the EP Act (as relevant to the flora and vegetation of the survey area).

The field survey was not undertaken in the prime season for the Pilbara (post-cyclone). However, consultation with the (then) DPaW was undertaken following the survey to confirm that all significant flora would have been observable on site at the time of the survey. Therefore, the survey timing was not considered to be a significant constraint.

3.2.2 Level 2 Vertebrate Fauna Survey

360 Environmental (2015a) was commissioned by Novo in August 2014 to undertake a single-phase level 2 terrestrial vertebrate survey at Beatons Creek (the survey area)

[4] As of December 2016, the EPA has updated this document; *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*. Review of the updated document indicates that the surveys are in line with current guidance.

(Appendix B). The survey was compliant with the EPA requirements for the environmental survey and reporting of fauna in WA and relevant EPBC Act survey guidelines, where practical and relevant, and as set out in the following documents:

- Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3 (EPA 2002);
- Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56 (EPA 2004b)[5];
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA-DEC 2010)[6];
- Survey Guidelines for Australia's Threatened Bats (DSEWPaC 2010a);
- Survey Guidelines for Australia's Threatened Birds (DSEWPaC 2010b);
- Survey Guidelines for Australia's Threatened Frogs (DSEWPaC 2010c);
- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a);
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b);
- Referral guidelines for the endangered northern quoll, *Dasyurus hallucatus* (DSEWPaC 2011c);
- Pilbara northern quoll regional monitoring guidelines, Department of Parks and Wildlife, Perth (Dunlop et. al. 2014); and
- Bushland Plant Survey. A Guide to Plant Community Survey for the Community (Keighery 1994).

The survey area was approximately 1,172 ha. The field survey was undertaken for a total of 11 days from 30 September – 10 October 2014. Four staff (Principal Zoologist, Zoologist and two Field Assistants) initially set up the trap sites, which included, trap site selection, digging of pitfall traps and fences and the laying out of Elliott and cage traps. After four days, the two Field Assistants returned to Perth. The objectives of the survey were to:

- Conduct a comprehensive desktop assessment of fauna databases and relevant literature;
- Undertake a baseline vertebrate survey in order to characterise fauna in the survey area;

[5] As of December 2016, the EPA has changed the name of this document to *Technical Guidance – Terrestrial fauna surveys*; however, the content of the document has not changed to date.
[6] As of December 2016, the EPA has changed the name of this document to *Technical Guidance – Sampling methods for Terrestrial vertebrate fauna*; however, the content of the document has not changed to date.

- Undertake a targeted conservation significant fauna survey, to map, estimate the population extent, describe and determine local and regional significance of conservation significant fauna in the survey area;
- Verify accuracy of the desktop assessment through ground truthing;
- Undertake habitat assessment and prepare habitat mapping including mapping of conservation significant fauna habitat where and when relevant (critical habitat); and
- Compilation of a fauna inventory.

3.2.3 Targeted Northern Quoll (Quoll) Survey

360 Environmental (2015b) was commissioned by Novo in December 2014 to undertake a targeted Northern Quoll survey at Beatons Creek (Appendix C). The survey area was approximately 1,172 ha. The trapping programme methods followed as closely as possible and where practical, the methodology outlined in the DPaW Pilbara Regional Quoll Project survey and monitoring document (Dunlop et. al. 2014).

The targeted survey was undertaken following the recording of one Northern Quoll on a motion sensitive camera in the survey area during the level 2 baseline vertebrate fauna survey described above. Prior to that, one Northern Quoll scat was collected during the level 2 flora and vegetation assessment of the same Beatons Creek survey area in September 2014. The primary objective of the targeted survey was to gain a better understanding of the distribution and relative abundance of the Northern Quoll across the survey area.

3.2.4 Targeted Pilbara Leaf-nosed Bat Survey

The calls of Pilbara Leaf-nosed Bats were detected on recorders laid out for the Level 2 fauna survey described in Section 3.2.2 at the Beatons Creek Project. Together with records in the Nullagine district at a small number of sites, these detections suggested that a previously unknown colony of Pilbara Leaf-nosed Bats exists in the district. The closest known Pilbara Leaf-nosed Bats roost is at the historical Copper Hills Mine, 28 km to the north. Other known roosts are over 75 km distant.

Bat Call (2015) carried out an extensive dry season survey in early December 2014 (Appendix H of Appendix B) utilising current industry standard bat ultrasonic detection systems to determine the presence of any Pilbara Leaf-nosed Bats diurnal roosts close to Nullagine. The aims of the survey were to:

- Confirm that the Pilbara Leaf-nosed Bats at Beatons Creek are originating from a previously unknown roost nearby;
- Confirm the presence or absence of any diurnal Pilbara Leaf-nosed Bats roost within Novo's impact area and extended tenements;

- Locate as closely as possible the exact location of the Pilbara Leaf-nosed Bats diurnal roost;
- Complete a census of the bats resident therein (if a roost cave was located) as this will provide baseline information for the project's ongoing management of the species in the area; and
- Provide an initial foraging habitat assessment within the study area.

3.2.5 Review of Existing Baseline Soil Data and Waste Rock Characterisation

Soil and Sediment Letter Report (Mine Earth 2015a)

Mine Earth was commissioned by Novo to undertake a review of baseline soil and sediment data collected by Pendragon Environmental Solutions (Pendragon) from the Paleoplacer Gold Project (Mine Earth 2015a, Appendix E). The purpose of this review was to:

- Develop a map of land systems within the Project area to assess differences in soil and sediment types throughout the land systems of the Project;
- Undertake statistical analysis on baseline soil and sediment data, to assess differences in soil types throughout the Project area;
- Prepare a topsoil inventory for Project disturbance areas, to inform rehabilitation planning; and
- Provide topsoil management and handling recommendations based on results of the baseline assessment.

The review covered the whole Paleoplacer Project including pending M46/532.

The intent of the letter report was to provide practical guidance in relation to the characteristics of soil types within the Project area and their applicability for use in rehabilitation activities. The data presented and discussed were sourced from an earlier data collection undertaken by Pendragon (2015a).

Waste Rock Characterisation Report (Mine Earth 2015b)

Mine Earth was also commissioned to assist Novo in undertaking an assessment of the physical properties of mine waste to identify waste rock with potentially deleterious or beneficial physical properties to inform waste rock dump (WRD) design and rehabilitation planning for the overall Paleoplacer Gold Project. The aim of the review was to assess the likely physical properties of waste rock and develop practical recommendations for handling waste rock, to support the approvals process for the Paleoplacer Gold Project.

Mine Earth worked with Novo geological staff to review available geological data and assess the likely stability properties of Project waste rock. Various data sources were used to inform the assessment including available literature, observations from geological staff, photographs of bulk sample excavations, core photographs and selected data from Pendragon (Mine Earth 2015a; 2015b).

Assessment of the Physical Properties of Mine Waste (Mine Earth 2017)

Mine Earth was engaged by Novo to complete an assessment of the physical properties of mine waste for the Beatons Creek Project. The objectives of the assessment were to a) determine the physical / erosion properties of waste rock samples via desktop review and laboratory analysis and b) determine whether stockpiled kaolinised sandstone will provide a useful low-permeability cover material.

A site visit was undertaken to the Project by Mine Earth and Novo personnel on 5 October 2017. During the visit, field observations were recorded, and four surface grab samples were collected from existing landforms. The four grab samples were submitted for laboratory testwork. The geomechanical properties (Atterberg limits and Emerson dispersion test [EDT]) were assessed for the conglomerate waste rock samples (BCK-01, BCK-02, BCK-03) to determine their physical characteristics and susceptibility to erosion. Clay mineralogy was assessed for the kaolinised sandstone stockpile to determine the presence of shrink / swell clays. The results from the laboratory testwork were used to derive the weathering behaviour and theoretical permeability of the samples based on their mineralogy, particle size distribution (PSD), cation exchange capacity, exchangeable sodium percentage, Atterberg limits and EDT results.

3.2.6 Beatons Creek Oxide Material AMD Assessment

SRK Consulting carried out a geochemical assessment of potential waste rock and tailings associated with the Paleoplacer Project to assess the project's risk of generating AMD (SRK 2015, Appendix D).

Geochemical assessment of materials to be mined demonstrated that the materials contain a limited source of stored acidity, which resulted low paste pH and negative acid neutralisation capacity (ANC). Materials classified for acid forming potential ranged from Non Acid-forming (NAF) to Potentially Acid-forming (PAF), however the majority of the PAF classified samples would still be considered as low-capacity PAF (SRK 2015). The majority of the PAF sampled was at more than 20 m below surface. BCG will not be mining deeper than 20 m within M46/532, thus most of the mining will only be the tops of the ridges, and will not intersect groundwater.

SRK and Mine Earth have undertaken an analysis of clay resources on site at Beatons Creek which have shown the clay to be NAF and an appropriate material for encapsulating any, anticipated to be low-capacity, PAF that may be encountered during mining (SRK 2015; Mine Earth 2017).

Any low-capacity PAF material that may be encountered during mining will be placed in the base of the WRD. The PAF material will be encapsulated in a designated cell with a low permeability NAF clay layer and dome shaped to prevent infiltration and ponding. The cell will then be covered by at least 5 m of NAF waste rock, which is anticipated to act as a 'store and release' cover (see Figure 4 of Auralia 2018; Appendix H).

3.3 Survey Results

3.3.1 Level 2 Flora and Vegetation Assessment

The MMWC flora and vegetation survey identified 173 species of flora from 91 genera and 43 families from a survey area of 1,172 ha. Three species of Priority flora were recorded during the survey:

- *Acacia aphanoclada* (Priority 1);
- *Acacia cyperophylla* var. *omearana* (Priority 1); and
- *Ptilotus wilsonii* (Priority 1).

None of the above listed species occur within the proposed amended clearing area. *Acacia aphanoclada* and *Acacia cyperophylla* var. *omearana* have previously been recorded in the Nullagine area. However, the confirmed record of *Ptilotus wilsonii* is the first official record of the species in the Pilbara bioregion and represents a range extension of approximately 200 km from previous locations near the Rudall River National Park, east of Nullagine.

Three species of introduced flora were recorded in the survey area: **Aerva javanica*, **Calotropis procera* and **Cenchrus ciliaris*. None of these species are listed as Weeds of National Significance by the Australian Government. One of these three species (**Calotropis procera*) is listed as a Declared Plant under the *Biosecurity and Agriculture Management Act 2013*.

Vegetation condition across the survey area ranged from Excellent to Completely Degraded with most of the survey area in Excellent condition. The area considered to be in Excellent condition was primarily represented by the outer hills through the north and the west of the survey area where historical exploration and prospecting activities had not previously occurred (Figure 4).

Eleven vegetation associations were mapped in the survey area (Figure 6). None of the vegetation associations are listed as a TEC under the EPBC Act, as an Environmentally Sensitive Area (ESA) under the EP Act or as a Priority Ecological Community (PEC) by DBCA. However, the survey area falls within the buffer zone for a PEC, the Mosquito Land System (Priority 3). The portion of the system located within the survey area is 0.08% of the total system.

3.3.2 Level 2 Vertebrate Fauna Survey

During the field survey, 65 species were recorded. These comprised of 22 species of reptile, from eight families, 29 bird species from 21 families and 14 mammal species from seven families. Five species of conservation significance were directly observed during the field survey, as described in Table 4.

Table 4: Vertebrate Fauna Survey Results

Species	Protection Designation	
	State (2018)	Commonwealth (2018)
Black-lined Ctenotus	Priority 1	N/A
Rainbow Bee-eater*	N/A	Marine
Western Pebble-mouse	Priority 4	N/A
Pilbara Leaf-nosed Bat (calls) (PLNB)*	Schedule 3 -Vulnerable	Vulnerable
Northern Quoll (single scat)*	Schedule 2 -Endangered	Endangered

*At the time of the survey, the Rainbow Bee-eater was listed as Schedule 5 under the WC Act and International Agreement under the EPBC Act. The PLNB and Northern Quoll were listed as Schedule 1 under the WC Act.

In total, four fauna habitats were identified in the survey area (Figure 7). These include Drainage Line, Hill, Dam and Degraded Mining Area. Habitat condition throughout the survey area ranged from Completely Degraded to Pristine. Drainage Line comprised 5.03% of the survey area, Hill habitat included 78.51% of the survey area, Dam comprised 1.56% and Degraded Mining Area included 14.90% of the survey area.

3.3.3 Targeted Northern Quoll Survey

A Northern Quoll scat was recorded during the Flora and Vegetation Survey and one Northern Quoll was recorded on a motion camera during the Fauna Survey. The camera was positioned at the entrance to an adit, in front of this entrance was a fig tree that had fruit on it (this was the same location that a scat was observed). A targeted survey was conducted in April 2015 and included 411 trap nights, 26 camera nights and a total of 20 person hours was spent searching for scats along transects and in other parts of the Survey Area that contained habitat often associated with the presence of Northern Quolls, such as drainage lines/ minor gorges and gullies and in disused adits. No scats were observed, no quolls were captured on camera and no quolls were caught in traps. The last Northern Quoll record for Nullagine was from 1979 and anecdotes from local residents indicate that they haven't seen Northern Quolls in the town for around 30 years. In the local region, the nearest and most recent Northern Quoll records come from the Blue Spec Mine (2011), McPhee Creek Mine (2012) and from BC Iron's Nullagine Project in 2008 which is about 25 km south west of Nullagine.

Habitat in the Survey Area for Northern Quolls would be at best described as low quality as there are few well-developed gullies or gorges with large crevices and boulders for them to shelter and den in and under. There are also no rock or boulder piles that are substantial enough for them to shelter and den in. Further to this there are no substantial watercourses in the Survey Area with large enough trees that would have hollows suitable for denning. The one Northern Quoll that was recorded on the motion camera in October 2014 was most likely denning in the adit adjacent to where it was recorded, particularly as there was a fig tree outside the adit. Northern Quolls are known to consume the fleshy fruits of figs and other plants.

It is important to note that many fauna (including Northern Quolls) are not distributed evenly across the landscape, are more abundant in some places than others, and consequently more detectable and this detectability can vary in space and time. In 2013, surveys were undertaken by (then) DPaW in the Nullagine region as part of the Pilbara Northern Quoll Regional Project. The nearest evidence of Northern Quolls (scats) comes from about 30 km west of Nullagine (Judy Dunlop pers. comm.). Northern Quolls may only use the Survey Area intermittently when there are resources available such as figs. Given the limited and sub optimal habitat in the Survey Area and the recording of only one scat in September 2014 and one Northern Quoll on a motion camera in October 2014, no records during the targeted April survey, there is unlikely to be a substantial population in the Survey Area.

3.3.4 Targeted Pilbara Leaf-nosed Bat Survey

During the survey, Pilbara Leaf-nosed Bat (PLNB) activity was detected generally across a 20 km radius circle centred on the Beatons Creek project that includes the majority of Novo's tenements in the district. Timing of the calls detected confirms that there is a previously unknown diurnal, and possibly maternal, roost in the Nullagine district. The exact location of the colony's roost was not found but the activity levels and temporal pattern of detections show that it is not immediately adjacent to Beatons Creek or within the development envelope of either the Paleoplacer or Bulk Sample Projects. The results suggest that the roost lies in one of the ridges to the south of Beatons Creek possibly within Novo's extended tenements.

The systematic methodology applied during this study to collect data to determine the likelihood of the location of diurnal roost cave(s) within the Beatons Creek project area was deemed sufficient to provide confidence in the finding that the Pilbara Leaf-nosed Bat diurnal roost is outside the proposed footprint of the Bulk and Paleoplacer Projects.

3.3.5 Review of Existing Baseline Soil Data and Waste Rock Characterisation

The review of baseline soil and sediment data (Mine Earth 2015a) includes recommendations for harvesting, storing and managing soil resources for rehabilitation at the Paleoplacer Project. Effective soil handling and management practices are critical for revegetation success. A recommendation was made to strip topsoil to a maximum depth of 200 millimetres (mm) as the native species seed bank and most of the biological activity occurs in the top 100 mm of the soil profile (Van Gorp & Erskine 2011). Soil samples collected from the Project area were characterised by slight to moderate dispersion. Low electrical conductivity (EC) values ranging from 2 – 11 µS/cm were recorded and considered non-saline.

The waste rock characterisation review (Mine Earth 2015b) suggested that excavation is expected to disturb the waste rock conglomerate such that the conglomerate matrix (approximately 30% of rock volume) becomes detached from gravel clasts (approximately 70% of rock volume). It is expected that the integrity of the gravel clasts would largely be preserved. This should have positive implications for surface stability as exposed areas of waste rock slopes should armour over time. Mine Earth (2017) undertook a site visit and further laboratory test work on the conglomerate waste rock to validate the performance of the waste rock once disturbed. The assessment concluded that conglomerate waste rock should demonstrate reasonable erosional stability. In terms of pH and salinity, the conglomerate waste rock samples presented no issues from a plant growth perspective. Effective drainage control is required to minimise the potential for erosion of the conglomerate waste rock, as it has a propensity to liquefy and remobilise when exposed to uncontrolled drainage. The stockpile of kaolinized sandstone from the drainage channel near Grants Hill, should provide a useful resource of low permeability cover material to encapsulated PAF rock should it be required (Mine Earth 2017; Appendix G).

3.3.6 Beatons Creek Oxide Material AMD Assessment

Geochemical assessment of materials to be mined (SRK 2015) demonstrated that the materials contain a limited source of stored acidity, which resulted in low paste pH and negative acid neutralisation capacity (ANC). Materials classified for acid forming potential ranged from Non Acid-forming (NAF) to Potentially Acid-forming (PAF); however, the majority of the PAF classified samples would still be considered as low-capacity PAF.

Long-term acid generation is not anticipated to be an issue regarding the materials to be mined. This is due to the low anticipated concentrations of sulphides such as pyrite. Any low-capacity PAF material that may be encountered during mining will be placed in the base of a Waste Rock Dump (WRD) to be constructed, encapsulated in designated cell with low permeability NAF clay (SRK 2016), and shaped to prevent ponding, before being covered by NAF waste rock which is anticipated to act as a ‘store and release’ cover.

NAF and low capacity PAF at Beatons Creek are visually distinct which will aid in the management of any low capacity PAF that might be encountered during mining. Note that Novo is taking a precautionary approach with the low capacity PAF given the presence of the P1 PDSWA. A PAF management procedure has been developed and will be implemented during operations, this PAF procedure has been reviewed and approved by DMIRS (REG ID 71318). Additionally, groundwater monitoring bores will be installed and monitored regularly for any potential seepage from the WRD.

4 Environmental Management Measures and Rehabilitation

In the event that the outcome of the assessment against the clearing principles indicates that the clearing may be or is likely to be at variance with one or more of the Ten Clearing Principles, the following may apply:

- The preparation and implementation of an Environmental Management Plan to support BCGs existing Environmental Management System; and/ or
- Other specific management actions.

BCG will undertake the following actions to ensure that clearing of native vegetation is avoided, minimised and reduced:

- Utilise existing access tracks where possible;
- Priority Flora locations will be retained where possible and clearly marked on site;
- Vehicles and equipment shall not be driven over, or parked on, vegetation and/or tree roots as far as practicable;
- Undertake staged clearing where possible;
- Locate support infrastructure on cleared land (e.g. stockpiles) where possible;
- No clearing beyond disturbance boundary;
- Undertake progressive rehabilitation during life of mine;
- Induct and educate personnel on environmental requirements of the Project;
- Mining will not intersect with groundwater;
- Ore will be processed offsite; and
- Machinery and/or plant equipment, where practical will be fitted with soundproofing equipment.

A Mining Proposal and Mine Closure Plan has been approved by DMIRS to cover mining of the Northern and Southern Operations areas within M46/9, 10, 11 and 532. This MPMCP will be updated to cover the mining of future operational areas, including the mining of the fresh material. The Mine Closure Plan will detail all closure practices and management measures as required. Broad closure objectives include, but are not limited to:

- Engineering of safe and stable final WRDs suitable for pastoral use of the land;
- Constructed WRDs to be stable and consistent with local topography;
- Vegetation in rehabilitated areas will have equivalent environmental values as surrounding natural ecosystems;

- Rehabilitation of final landform to support self-sustaining, functional ecosystems comprising suitable, local flora species as far as available resources allow (noting parts of the footprint have been cleared and are devoid of native vegetation);
- P1 PDWSA status not impacted through BCGs activities; and
- Values of the Nullagine Dam will not be adversely affected (used by some locals for recreational purposes).

5 Assessment against the Ten Clearing Principles

The proposed clearing activities for the amended areas only (Figure 3), have been assessed against the ten clearing principles regarding the DER *Guide to Assessment: Clearing of Native Vegetation under the EP Act*, and in consideration of the current extent and condition of the native vegetation on the site. This assessment is presented in Table 5.

Table 5: Assessment Against the Ten Clearing Principles

PRINCIPLE	ASSESSMENT
Principle (a) – Native vegetation should not be cleared if it comprises a high level of biological diversity	Three taxa of conservation interest were recorded in the MMWC flora and vegetation survey: *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1) (MMWC 2015). The primary population of *Acacia aphanoclada* (P1) recorded during the survey is well outside of the proposed clearing area (Figure 5). A total of 1,686 individuals of *Acacia aphanoclada* were recorded during the survey. The majority are outside the clearing footprint. The records of *Acacia cyperophylla* var. *omearana* (P1) species within the survey area were on the very south-western boundary of the survey area with a larger population outside the survey area. None of the individuals of this species will be impacted as the proposed clearing will not occur in this area (Figure 5). *Ptilotus wilsonii* (P1) has not previously been recorded within the Pilbara bioregion and represents a range extension of approximately 200 km. It is possible further surveys in the Nullagine area would present further records of this species. The two plants/populations located within the survey area are not proposed to be cleared. No Threatened flora species listed under the EPBC Act and / or gazetted as Threatened under the *Biodiversity Conservation Act 2016* (BC Act) were recorded.

PRINCIPLE	ASSESSMENT
	Vegetation Condition ranges from Excellent to Completely Degraded with most of the survey area in Excellent Condition (Table 6).

Table 6: Vegetation Condition and Extent in the Survey Area (Trudgen 1991)

Condition	Extent in MMWC Survey Area (MMWC 2015)	
	HA	%
Excellent	589.2	50.7
Very Good	387.33	33.3
Good	78.53	6.8
Poor	7.12	0.6
Very Poor	8.02	0.7
Completely Degraded	91.8	7.9
Total	**1,162**	**100**

The survey recorded 173 taxa, which is lower than, but generally comparable, to the number of taxa recorded in previous surveys conducted near Nullagine, namely, 294 taxa (Plant Ecology Consulting 2013) and 259 taxa (Mattiske Consulting 2010). These previous surveys cover areas larger than that of the Beatons survey area and comprised a greater complexity of vegetation. Average species richness from the survey was 15.3 taxa per quadrat from 41 quadrats. The flora of the survey area is generally typical of the eastern Pilbara and the species list is similar to that recorded by Plant Ecology Consulting (2013) and Mattiske Consulting (2010). The survey of the Beatons Creek area returned the same three dominant families (Fabaceae, Poaceae and Malvaceae) and the same three dominant genera (*Acacia*, *Ptilotus* and *Senna*) as both Plant Ecology Consulting (2013) and Mattiske Consulting (2010). Therefore, the Paleoplacer Project area has moderate biological diversity.

There are no botanical ESAs within or adjacent to the Project area. The nearest ESA is the Fortescue Marsh, approximately 80 km south. No PECs were recorded within the Paeloplacer Project area; however, the

<table>
<tr><th>PRINCIPLE</th><th>ASSESSMENT</th></tr>
<tr><td></td><td>
Project area is within the buffer for the PEC associated with the Mosquito Creek Land System (Priority 3). The footprint is located within the Capricorn Land System and the Mosquito Land System. As outlined in Table 7, these land systems are not considered to be restricted in area or distribution, and the Project area comprises a small percentage of the extent.
Table 7: Land Systems of the Survey Area
<table>
<tr><th rowspan="2">Land System</th><th colspan="2">Area of Land System in the Pilbara Bioregion</th><th colspan="2">Area of Land System in the Survey Area</th><th rowspan="2">Extent of Total Land System Represented within the Survey Area</th></tr>
<tr><th>AREA (Km²)</th><th>% OF PILBARA BIOREGION</th><th>AREA (KM²)</th><th>% OF SURVEY AREA</th></tr>
<tr><td>Capricorn</td><td>5,296</td><td>2.9%</td><td>10.3</td><td>87.6%</td><td>0.19%</td></tr>
<tr><td>Mosquito</td><td>1,840</td><td>1%</td><td>1.46</td><td>12.4%</td><td>0.08%</td></tr>
</table>
The vegetation in the proposed amended clearing area ranges from Excellent to Very Good condition (Figure 4). Most of the disturbance will occur in Excellent condition (Figure 4).
Considering the flora survey revealed similar results to surrounding surveys in the area, the impact area does not contain high levels of biological biodiversity. Additionally, no clearing of any Priority species will occur in amended proposed clearing area, and no other significant native vegetation environmental values are present within the area.
Assessed Outcome: The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (a).
</td></tr>
<tr><td>Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant</td><td>
During field surveys for the Paleoplacer Project, the Black-lined Ctenotus, Northern Quoll, Pilbara Leaf-nosed Bat and Western Pebble-mouse were recorded (360 Environmental 2015a; 2015b). Since the survey was undertaken, the Ghost Bat was listed under the BC Act and EPBC Act as Vulnerable. During the fauna survey, the Ghost Bat was not recorded in the area, but was considered likely to occur.
</td></tr>
</table>

PRINCIPLE	ASSESSMENT
habitat for fauna indigenous to Western Australia.	Black-lined Ctenotus (P1) During the survey, this species was recorded in 'Hill' and 'Drainage' habitat. Given the extent of this habitat in the survey area and in the broader region, and the 19 records in the DBCA database, this species is likely to be more common and widespread. As a result, activity and disturbance associated with mining in the survey area is unlikely to significantly impact this species at the local or regional scale. Northern Quoll (Threatened – Endangered) At the time of the survey the Northern Quoll was listed as Schedule 1 under the BC Act (Critically Endangered), it is now listed as Schedule 2 (Endangered). It is still listed as Endangered under the EPBC Act. During the Level 2 survey in 2014, one Northern Quoll was recorded on a motion camera in the survey area. Following the identification of one quoll scat at the same location during the botanical survey, a targeted Northern Quoll survey was undertaken. No Quolls were captured in cage traps during the targeted survey. Habitat in the Survey Area for Quolls would be at best described as low quality as there are few well-developed gullies or gorges with large crevices and boulders for shelter and denning. There are also no rock or boulder piles that are substantial enough as habitat. There are no substantial natural watercourses in the survey area with large enough trees that would have hollows suitable for denning (DEE 2016a). The one Quoll that was recorded on the motion camera in October 2014 was most likely denning in the adit adjacent to where it was recorded, particularly as there was a fig tree outside the adit. Quolls are known to consume the fleshy fruits of figs and other plants. Given the limited and sub optimal habitat in the survey area, and the recording of only one scat in September 2014 and one Quoll on a motion camera in October 2014, and no records during the targeted survey in 2015, there is unlikely to be a substantial population in the survey area. Disturbance associated with mining in the survey area is unlikely to significantly impact this species at the local or regional scale. Pilbara Leaf-nosed Bat (PLNB) (Threatened - Vulnerable)

PRINCIPLE	ASSESSMENT
	At the time of the survey, the PLNB was listed as Schedule 1 under the BC Act, it is now listed as Schedule 2 – Endangered. It is still listed as Vulnerable under the EPBC Act. During the Level 2 survey, calls of the PLNB were detected in low numbers at two locations. A targeted PLNB survey was undertaken at the beginning of December 2014. During the targeted survey, PLNB activity was detected at many sites across a 20 km radius around the survey area. Timing of the detected calls indicates that there is a previously unknown diurnal, and possibly maternal, roost in the Nullagine district. The exact location of the colony's roost was not located, but the activity levels and temporal pattern of detections show that it is not within or immediately adjacent to the survey area. The results suggest that the roost lies in one of the ridges to the south of Beatons Creek, outside of the areas being considered for mining by the Paleoplacer Project. Western Pebble-mouse (Priority 4) One Western Pebble-mouse was captured in Hill habitat and disused Pebble-mouse mounds were found at two locations. The DBCA threatened fauna database records show eight observations of the Western Pebble-mouse in the Nullagine area since 1993, with four after 2011. The survey area contains suitable habitat, such as hills and slopes that are covered in small pebbles. This species is found broadly across much of the Pilbara (Gibson & McKenzie 2009); therefore, any localised loss of habitat within the study area is unlikely to significantly impact this species overall conservation status. Ghost bat (Threatened - Vulnerable) *Macroderma gigas* (Ghost Bat) was listed as a Priority 4 species under the DBCA priority list whilst the surveys were being undertaken. The Ghost Bat has recently been listed under the BC Act and EPBC Act as Vulnerable. During the fauna survey, the Ghost Bat was not recorded in the area, but was considered likely to occur. DBCA database search results (360 Environmental 2015a) show the Ghost bat has been recorded from McPhee Creek (30 km North of the survey area) and Lionel Mine (40 km North West of the survey

PRINCIPLE	ASSESSMENT
	area). Key habitat for the Ghost Bat includes roost sites (caves, rock crevices and disused mine adits [DEE 2016]). Suitable roost sites consist of generally deep natural caves or deep disused mines with a relatively stable temperature of 23°–28°C and a moderate to high relative humidity of 50–100% (DEE 2016). The potential roost sites within the Paleoplacer Project consist of historical mines with shallow surface adits, shafts and surface workings; however, as these are generally shallow, cave density was considered to be low (Bat Call 2015) and, therefore, these roost sites are not considered to be suitable roost sites for the Ghost Bat. Loss of foraging habitat is also considered to be a threat; however, as foraging areas are centred 1.9 km (average) from daytime roost and Ghost bats generally return to the same areas each night (DEE 2016), the absence of appropriate roost sites indicates the proposed mining area does not contain key foraging habitat for the Ghost Bat. <u>Fauna Habitat – Terrestrial Vertebrates</u> Four fauna habitats were identified in the survey area; Drainage Line, Hill, Dam and Degraded Mining Area. Habitat condition throughout the survey area ranged from Completely Degraded to Pristine. Drainage Line comprised 5.03% of the survey area, Hill habitat included 78.51% of the survey area, Dam comprised 1.56% and Degraded Mining Area included 14.90% of the survey area. The Project intersects three of these habitats (excluding the Dam) (Figure 7). Hill habitat was typically comprised of *Eucalyptus leucophloia* and *Corymbia hamersleyana* scattered low trees over mixed *Acacia* spp. over *Triodia* spp.. There was a lower diversity of microhabitats in this habitat with few large trees, few if any tree hollows, few if any hollow logs, and little woody debris. The soil was hard and unsuitable for burrowing fauna as there was exposed bedrock (limited small piles of rock) providing cracks and crevices which are important shelter sites for small ground dwelling reptiles and some small mammals. As such this habitat type is considered to be of moderate value.

PRINCIPLE	ASSESSMENT
	The Degraded Mining Area habitat was either cleared or completely degraded. Habitat was typically comprised of *Acacia* spp. and *Triodia* spp. (both with limited cover), roads, tracks, mine pits, borrow pits and all areas that have been cleared of vegetation as a result of historic mining activity or as part of the exploration programme for this current project. This habitat provides limited value to most fauna. However, some of the commonly recorded and widespread bird species were seen in this habitat, for example the Spinifex Pigeon, Torresian Crow and Black Kite. The Degraded Mining Area habitat is considered to be of limited value as there is little vegetation (limited cover), no trees with hollows and very little woody debris. The lower Drainage Line habitat is characterised by soft, red-brown sandyloam soils, with a mix of *E. leucophloia* and *Melaleuca glomerata* trees. These trees offer moist and shady conditions and the soils are suitable for burrowing fauna species. Upper drainage line habitat is more incised and forms minor gorge habitat where caves (though limited) provide habitat for various bat species (potentially including the PLNB). Small pools of semi-permanent water provide drinking opportunities for birds and mammals. Clearing of the drainage habitat will be minor, and the habitat is well represented outside of the disturbance area. Fauna such as Northern Quolls and PLNB may use these areas for foraging, but it is not considered critical habitat and there is not a population of either of these species established within the general Paleoplacer Project Area (360 DEE 2016a; Environmental 2015a). Given the extent of these habitats in the survey area and especially in the broader region, activity and disturbance associated with the Paleoplacer Project is unlikely to significantly impact on fauna in the survey area, but most certainly not at a regional scale (360 Environmental 2015a). <u>Fauna Habitat – Subterranean</u> A desktop assessment of stygofauna and troglofauna was undertaken by Pendragon Environmental Solutions Pty Ltd to evaluate the risk associated with the proposed overall Paleoplacer Project; this assessment was

PRINCIPLE	ASSESSMENT
	summarised by Klohn Crippen Berger (KCB 2017; Appendix I). A desktop assessment was considered appropriate due to the following: • The mined material is located above the water table (except for a minor area in the Grants Hill pit); • Dewatering will not be required to enable mining; and • Low AMD risk associated with the waste material suggests negligible impact on local groundwater quality. Results suggest that any stygofauna present within the Paleoplacer Project will be within the regionally extensive groundwater system, Mosquito Creek Formation Aquifer. KCB (2017) considered that any stygofauna or troglofauna populations that may occur within the area are not restricted in their distribution as the system in regionally interconnected. Groundwater levels at the site range from 20 to 50 mbGL (SRK 2018). The Alluvial and Paleoplacer project will not intercept groundwater, except for a portion of the Grants Hill pit during future operations of the Fresh Material. BCG proposes to extract groundwater to aid in dust suppression via an existing bore within M46/11 (groundwater licence 178635). Given the Licensed use of a limited amount of groundwater (for dust suppression) and that groundwater will not be intercepted during mining across the majority of the Project area, significant impacts to stygofauna (direct removal of habitat) or troglofauna (indirect impact to habitat via de-humidfying impacts of dewatering) are not anticipated. <u>Fauna Habitat – Short-Range Endemics (SRE) Invertebrates</u> Information on SRE and listed invertebrate species was compiled via desktop review by Bennelongia Environmental Consultants for the additional proposed clearing area (the Project) (Bennelongia 2018) (Appendix L). The review aimed to collate existing information on SREs and listed invertebrates in the vicinity of the Project, as well as to collect information about habitats likely to support SRE habitats within the Project. The EPA requires that the Proponent considers the risk to short-range endemic invertebrates

PRINCIPLE	ASSESSMENT
	(SREs), which are species of ground-dwelling invertebrates with ranges of less than 10,000 km^2. SREs have patchy occurrences within this small range because they are confined to discontinuous, usually refugial, habitats (EPA 2016a and 2016b). The Project comprises highly exposed hills and ridges that support only hummock grasslands and are not prospective for SREs. No listed invertebrates, confirmed or potential SREs were recorded at the Project. The highly exposed, widespread and uniform nature of habitat at the Project together with museum search results suggest there is likely to be a depauperate community of terrestrial invertebrates present at the Project of which none would be actual SREs (Bennelongia 2018). The Project area is small in extent (270 ha) and this small size, together with the non-prospective habitats and low richness of species in SRE Groups (of which none are confirmed SREs) in the vicinity, makes it unlikely the Project will affect the conservation status of any SRE species in the local region (Bennelongia 2018). Considering the Paleoplacer Project has moderate to limited value, and is not considered necessary for the maintenance of any significant habitat for indigenous fauna and that fauna recorded are representative of the wider area, the additional proposed clearing is not likely to have significant impacts. **Assessed Outcome:** The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (b).
Principle (c) – Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora	Three species of Priority flora were recorded within the MMWC flora and vegetation survey area; *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1). No species of Threatened flora were recorded during field surveys (Figure 5). The only species identified in the desktop assessment as potentially being present was *Lepidium catapycnon* (Declared Rare at the time of the survey). This species is no longer considered to be Declared Rare and has been downgraded to Priority 4.

PRINCIPLE	ASSESSMENT
	<u>*Acacia aphanoclada*</u> A total of 1,686 individuals of *Acacia aphanoclada* were recorded during the survey. *Acacia aphanoclada* primarily occurred within vegetation association ElAaAoAhTbTe in the north-eastern portion of the survey area with scattered individuals recorded in the southern half of the survey area. No species will be cleared in the amended clearing area. This is not expected to be a significant impact to the species, given that the species and its habitat (vegetation association ElAaAoAhTbTe) is well represented outside of the amended clearing area (Figure 5). <u>*Acacia cyperophylla* var. *omearana*</u> Three individuals were recorded in vegetation association ElAoAsAhTbTe on the survey boundary, and are not within the proposed clearing area. Advice from DBCA in October 2014 considered the conservation status of *Acacia cyperophylla* var. *omearana* should be reviewed with the view of upgrading the conservation status to Threatened (pers. comm. Stephen van Leeuwen). No further progression of this situation has occurred to date by DBCA, it is outside of the proposed amended clearing area. <u>*Ptilotus wilsonii*</u> Two individuals of this species were recorded during the survey. One individual occurred within the vegetation association ElAoAsAhTbTe and the other individual occurred within ElAbTeTb, neither location is within the proposed amended clearing area. **Assessed Outcome:** The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (c).
Principle (d) – Native vegetation should not be cleared if it comprises the whole or a part of, or is	No records of a TEC occur within a 20 km radius of the Paleoplacer Project area (DPaW 2014b, DBCA 2019). Two TECs are known to occur in the Pilbara bioregion: *Themeda* grasslands and the Ethel Gorge Aquifer Stygobiont community. Neither of these communities occur within the Project area (Figure 5). The PEC Mosquito Land System buffer is located within the amended clearing area, but only on the very edge of the

PRINCIPLE	ASSESSMENT
necessary for the maintenance of a Threatened Ecological Community (TEC)	PEC buffer; and the PEC extends widely to the east. It is not expected that the minor intersection and minimal clearing (<1%) within the PEC buffer will impact this land system. **Assessed Outcome:** The amended proposed clearing area is unlikely to be at variance with Principle (d).
Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared	Vegetation mapping of the Nullagine area was completed on a broad scale (1:250,000) by Beard (1972-80). These vegetation units were re-assessed by Shepherd et al. (2001) to account for clearing in the intensive land use zone, dividing some larger vegetation units into smaller units. There are two Beard / Shepherd vegetation units in the amended clearing area. The Shepherd et al. (2001) vegetation unit is described as follows: • **Abydos Plain – Chichester_173**: Shrub-steppe. Hummock grassland with scattered shrubs of mallee *Triodia sp. Acacia spp., Grevillea spp. Eucalyptus* spp. • **Abydos Plain – Chichester_190**: Sparse shrub-steppe. Hummock grassland with sparse shrubs *Triodia spp. Acacia* spp.

Table 8: Broad Vegetation Types and its State and Regional Representation (DBCA 2018)

VEGETATION ASSOCIATION	PRE-EUROPEAN AREA (HA)	CURRENT EXTENT (HA) 1	REMAINING (%)	CURRENT EXTENT % IN DBCA MANAGED LANDS
Vegetation Types (Beard 1979/ Shepherd *et al.* 2001) in the state				
173	1,753,104.09	1,748,260.83	99.72	13.65
190	169,199.72	169,051.00	99.91	-
Vegetation Types (Beard 1979/ Shepherd *et al.* 2001) in the Pilbara bioregion				
173	1,752,520.89	1,747,677,63	99.72	13.66
190	169,199.72	169,051.00	99.91	-

<table>
<tr><th>PRINCIPLE</th><th>ASSESSMENT</th></tr>
<tr><td></td><td>
<table>
<tr><td colspan="5">Vegetation Types (Beard 1979/ Shepherd et al. 2001) in the Chichester subregion</td></tr>
<tr><td>173</td><td>1,744,029.51</td><td>1,739,189.58</td><td>99.72</td><td>13.73</td></tr>
<tr><td>190</td><td>169,199.72</td><td>169,051.00</td><td>99.91</td><td>-</td></tr>
<tr><td colspan="5">Vegetation Types (Beard 1979/ Shepherd et al. 2001) in the local government area (Shire of East Pilbara)</td></tr>
<tr><td>173</td><td>1,085,704.90</td><td>1,081,937.46</td><td>99.65</td><td>9.93</td></tr>
<tr><td>190</td><td>169,199.72</td><td>169,051.00</td><td>99.91</td><td>-</td></tr>
</table>
According to the EPA's Guidance Statement No. 33, the national target is to have clearing controls in place to prevent the removal of ecological communities which are below 30% remaining (of the Pre-European extent). The EPA considers it is important that ecological communities are maintained above the threshold level of 30% of the original pre-clearing extent of each community, as communities below this threshold level show the species loss appears to accelerate exponentially at the ecosystem level (EPA 2008). The current extent of vegetation types at all levels (State, bioregion, subregion and local government) is more than 99% for both vegetation complexes and therefore well represented and well above the EPA threshold.
Assessed Outcome: The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (e).
</td></tr>
<tr><td>Principle (f) – Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland</td><td>M46/11 contains a man-made dam which was constructed by Nullagine locals in the 1980s (Figure 9). The dam has since become a wetland feature and supports a range of flora and fauna (none recorded as priority or Threatened by MMWC [2015]). The overflow from the dam flows into the Nullagine River outside of the survey area. Beatons Creek flows outside the survey area, south of the survey area boundary until it meets the Nullagine River near the Nullagine town site. Surface water in at the Paleoplacer Project area flows either towards the dam from catchment four or towards the town of Nullagine and into the Nullagine River from catchments one, two and three (Figure 9). Beatons Creek is situated immediately south of the southern boundary of the survey area, and flows east into the Nullagine River. The Paleoplacer Project at Beatons Creek will not intersect with any rivers. There is no need or requirement to clear any of the vegetation</td></tr>
</table>

PRINCIPLE	ASSESSMENT
	associated with the dam or the main creekline flowing into the dam. It is unlikely there will be impacts to surface water flows within the area. **Assessed Outcome:** The amended proposed clearing area is unlikely to be at variance with Principle (f).
Principle (g) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation	Land degradation may include the clearing of vegetation that leads to soil erosion, soil acidity, salinity, decline in vegetation condition due to weeds and changes in natural fire regimes, and a decline in soil condition caused by wind and water erosion. The Project is situated within the Capricorn Land System and the Mosquito Land System. The Capricorn Land System has no record of severely degraded or eroded land throughout its extent, and the Mosquito Land System has no record over 97% of its extent (van Vreeswyk *et al.* 2004). The scale of clearing of vegetation proposed under this application (up to 75 ha) is not likely to cause appreciable land degradation within these systems. The Mine Earth report (2015a) states that soil analyses demonstrated slight to moderate dispersion capacity. A Waste Rock Characterisation Report by Mine Earth (2015b) also expected that the integrity of the gravel clasts should largely be preserved. This should have positive implications for surface stability as exposed slopes should self-armour over time. Low electrical conductivity (EC) values ranging from 2 – 11 µS/cm were recorded and are considered to be non-saline, and so it is not considered likely that salinity could be increased on or off site. The proposed amended clearing areas are not within mapped acid sulphate soils areas and any potentially acid forming material is well below the surface (20-25 m) within the oxide-sulphide zone (Mine Earth 2015b). Therefore, clearing of vegetation at the surface is not likely to cause acidic soils. No chemicals that could result in nutrient export will be used for the Project. Waterlogging is not considered to be an issue given high local evaporation rates (300-400 mm per annum), and because no riparian vegetation would be cleared. Any water fall would be expected to follow natural surface water flows.

PRINCIPLE	ASSESSMENT
	BCG will undertake progressive rehabilitation across the entire site in accordance with their closure/rehab and decommissioning schedule required by the Mine Closure Plan. This will ensure any exposed areas are stabilised and vegetation is regrowing as soon as practicable to minimise soil erosion from wind and water. **Assessed Outcome:** The amended proposed clearing area is unlikely to be at variance with Principle (g).
Principle (h) – Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area	The survey area is not located within or adjacent to any conservation reserves. The closest DBCA managed conservation estate is Karijini National Park, which is approximately 146 km south west of the survey area. There are no ESAs within or adjacent to the survey area and there are no TECs recorded within 50 km of the survey area. The Paleoplacer Project is situated within a Schedule 1 Area (as recognised under the Environmental Protection [Clearing of Native Vegetation] Regulations 2004). The Schedule 1 Area encompasses the Nullagine Water Reserve and includes a Priority 1 Public Drinking Water Supply Area (PDSWA) which is approximately 8876.65 ha (DWER 2017; Water and Rivers Commission 1999). Clearing of vegetation is unlikely to cause impacts to the town water supply as follows: • The groundwater table is at depth across the Project area at 20 to 50 mbGL (SRK 2018); • Any potentially acid forming materials are at depth across the Project area (20-25 m) and therefore clearing of vegetation at the surface will not result in acid generating environment; • The Project does not require chemical inputs (apart from diesel fuel, refuelling will occur offsite); and • DWER has been consulted regarding the Bulk Sample Project, and overall Paleoplacer Gold Project and have agreed that the risk of the project to the PDSWA is reduced since the majority of processing will now occur off-site. Potential impacts to the PDSWA from mining operations has been reviewed by DMIRS and DWER and approved under REG ID 71318. Clearing of vegetation is unlikely to impact the PDSWA and native

PRINCIPLE	ASSESSMENT
	vegetation is expected to establish towards a natural functioning ecosystem after closure (based on soil analysis and rehabilitation trials). **Assessed Outcome:** The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (h).
Principle (i) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	The Paleoplacer Project occurs in the Public Drinking Water Source Area (PDWSA) Priority 1 Nullagine Water Reserve Protection Area. Priority 1 (P1) source protection areas are defined to: *Ensure that there is no degradation of the water source. P1 areas are declared over land where the provision of the highest quality public drinking water is the prime beneficial land use* (Water and Rivers Commission 1999). See Principle h for further discussion. No Groundwater Dependant Ecosystems (GDEs) were identified within the Project area (SRK 2018). Given no drawdown impacts are expected and no GDEs have been identified, no impacts to GDEs are anticipated from the Project. No impacts to surface water quality are anticipated as no chemicals are to be used other than vehicle fuels/ fluids; vehicles and machinery will re-fuel offsite. The Project is not within a mapped Acid Sulphate Soils area and soils are not considered saline (Mine Earth 2015b). The water table is at depth (20 – 50 mbGL) and therefore clearing of vegetation is not likely to impact on groundwater. **Assessed Outcome:** The amended proposed clearing area is <u>unlikely</u> to be at variance with Principle (i).
Principle (j) – Native vegetation should not be cleared if clearing the vegetation is likely to cause,	There were small pools in some of the creek lines within the MMWC (2015) survey area at the time of survey (early September 2014). However, this appeared to be surface water collection remaining from recent rainfall. There did not appear to be any perennial pools within the creek lines, however the dam holds water year round. The closest BoM station is in Marble Bar, approximately 89 km northeast of Nullagine. Climate data is available for years 2000 to 2018. The minimum average monthly temperature ranges from approximately

PRINCIPLE	ASSESSMENT
or exacerbate, the incidence of flooding	12.2˚C to 26.5 ˚C and maximum average monthly temperature ranges approximately 27.0˚C to 41.8˚C (BoM 2017). Rainfall of >1mm averages 28.6 days per year, with the maximum mean rainfall being 107.7 mm during January. The annual average rainfall received at this station is approximately 392.3 mm per annum. Nullagine has an annual evapotranspiration rate of between 300-400 mm (BoM 2017). Native riparian vegetation will not be cleared from the Nullagine River or Beatons Creek to facilitate the Project. It is unlikely that the proposed clearing for the Project will cause or exacerbate the incidence or intensity of flooding, cause increased runoff or alter any major water courses. **Assessed Outcome:** The amended proposed clearing area is unlikely to be at variance with Principle (j).

6 Summary of Assessment and Conclusion

In summary and following various desktop and field assessments of the environmental values of the overall Paleoplacer Project area, it is considered that the proposed amended clearing area of up to 75 ha is unlikely to be at variance with any of the ten clearing principles contained in the EP Act.

The key impact associated with the proposed amended clearing area is the clearing of up to 75 ha of native vegetation. The biodiversity of the Project area is well represented outside of the proposed amended clearing area, and the proposed clearing is not expected to contribute to significant land degradation. BCG will only clear vegetation that is absolutely necessary as well as undertake progressive clearing and rehabilitation during operations in order to promote successful ecological restoration at closure. BCG has taken conservative measures to manage any exposed potential PAF material onsite, reduced impacts by not undertaking processing activities on site and refuelling of machinery offsite. The proposed clearing together with operational environmental management measures are not likely to result in significant impacts at the Paleoplacer Project.

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FIGURES

Legend

Mining Lease

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2017)
- VEGETATION CONDITIONS BASED ON SURVEY BY MMWC 2014
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2017 (© Western Australian Land Information Authority 2017)

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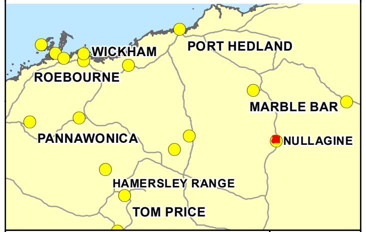
LOCALITY MAP



PROJECT ID	DATE
3590	18/10/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
LF	HT	HT	0

Beatons Creek Gold Pty Ltd

NVCP Amendment

Figure 1
Site Location

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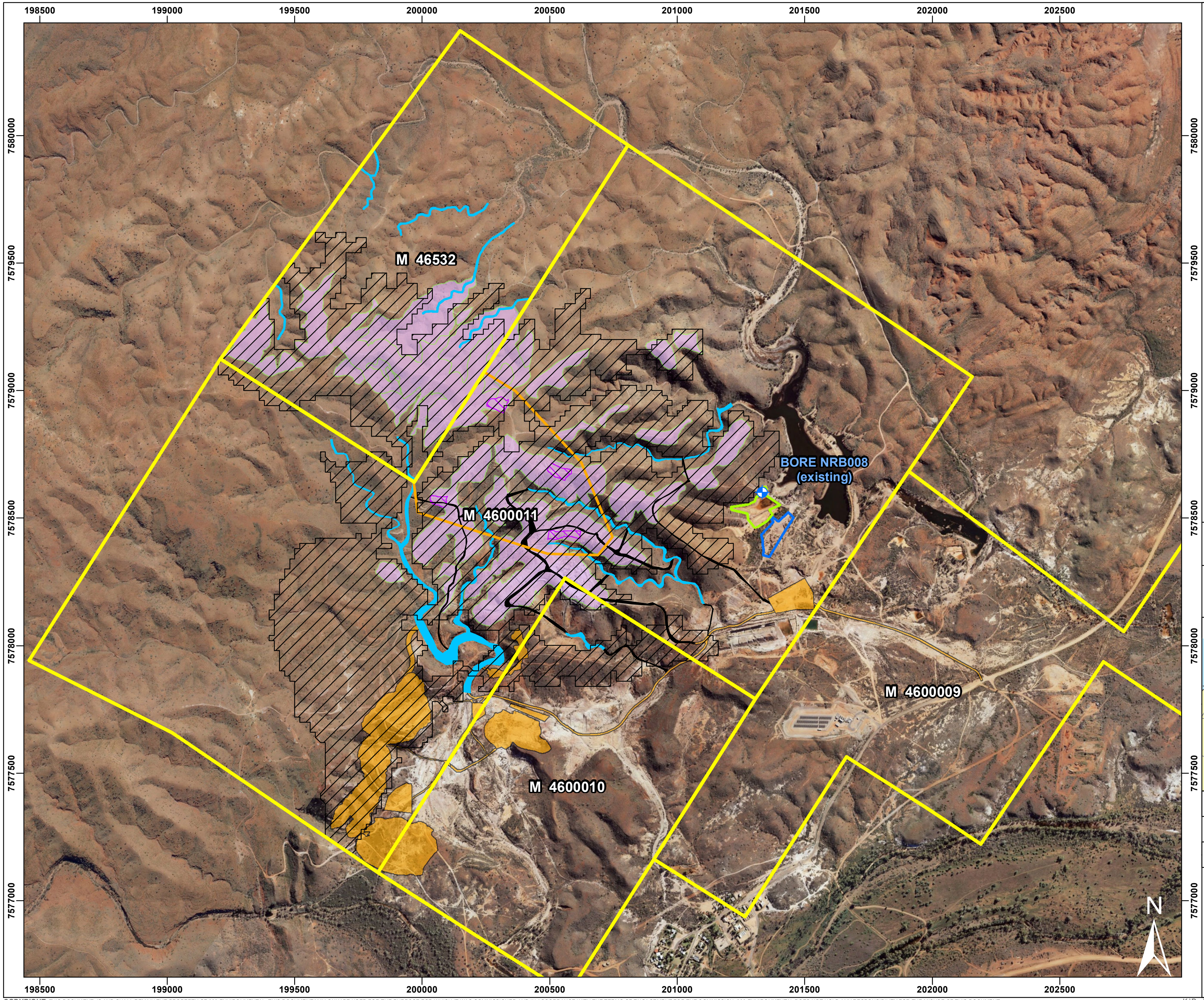

Legend

Mining Lease

Approved under REG ID 58019, REG ID 59827 and 71318

- Northern Mining Operations
- Southern Mining Operations
- Processing Domain
- Sedimentation Domain
- Approved Bulk Sample Process Clearing Footprint
- Alluvials Creekline Extraction
- Haul/Access Roads

MPMCP in Preparation

- Proposed Disturbance Area (fresh material)

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
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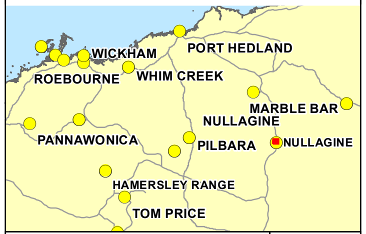
LOCALITY MAP



PROJECT ID	DATE
3590	28/10/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
LF	HT	HT	0

Beatons Creek Gold Pty Ltd

NVCP Amendment

Figure 2
Project Stages

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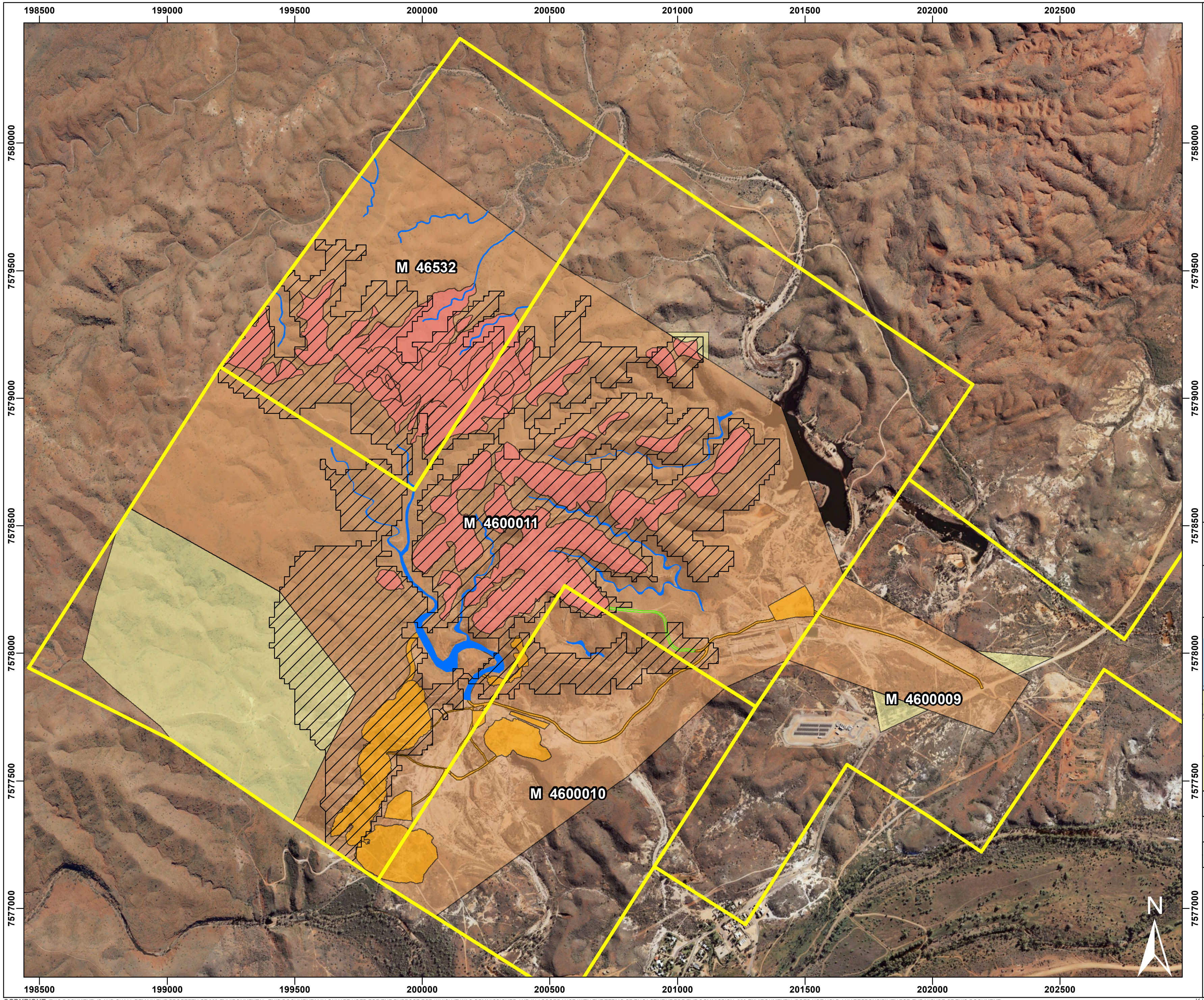

Legend

- Mining Lease
- Northern Operations Disturbance Area
- Southern Operations Disturbance Area
- Alluvials Creekline Disturbance Area
- Aproved Clearing Areas (195ha) under CPS7440/2
- Ammended Clearing Area
- Proposed Disturbance Area (fresh material)

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
- VEGETATION CONDITIONS BASED ON SURVEY BY MMWC 2014
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2017 (© Western Australian Land Information Authority 2017)

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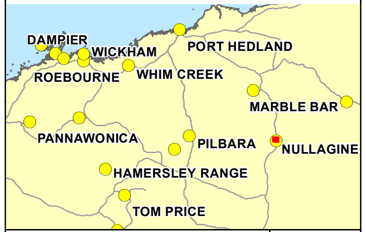
LOCALITY MAP



PROJECT ID	DATE
3590	28/10/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
LF	HT	HT	0

Beatons Creek Gold Pty Ltd

NVCP Amendment

Figure 3

Disturbance Envelope

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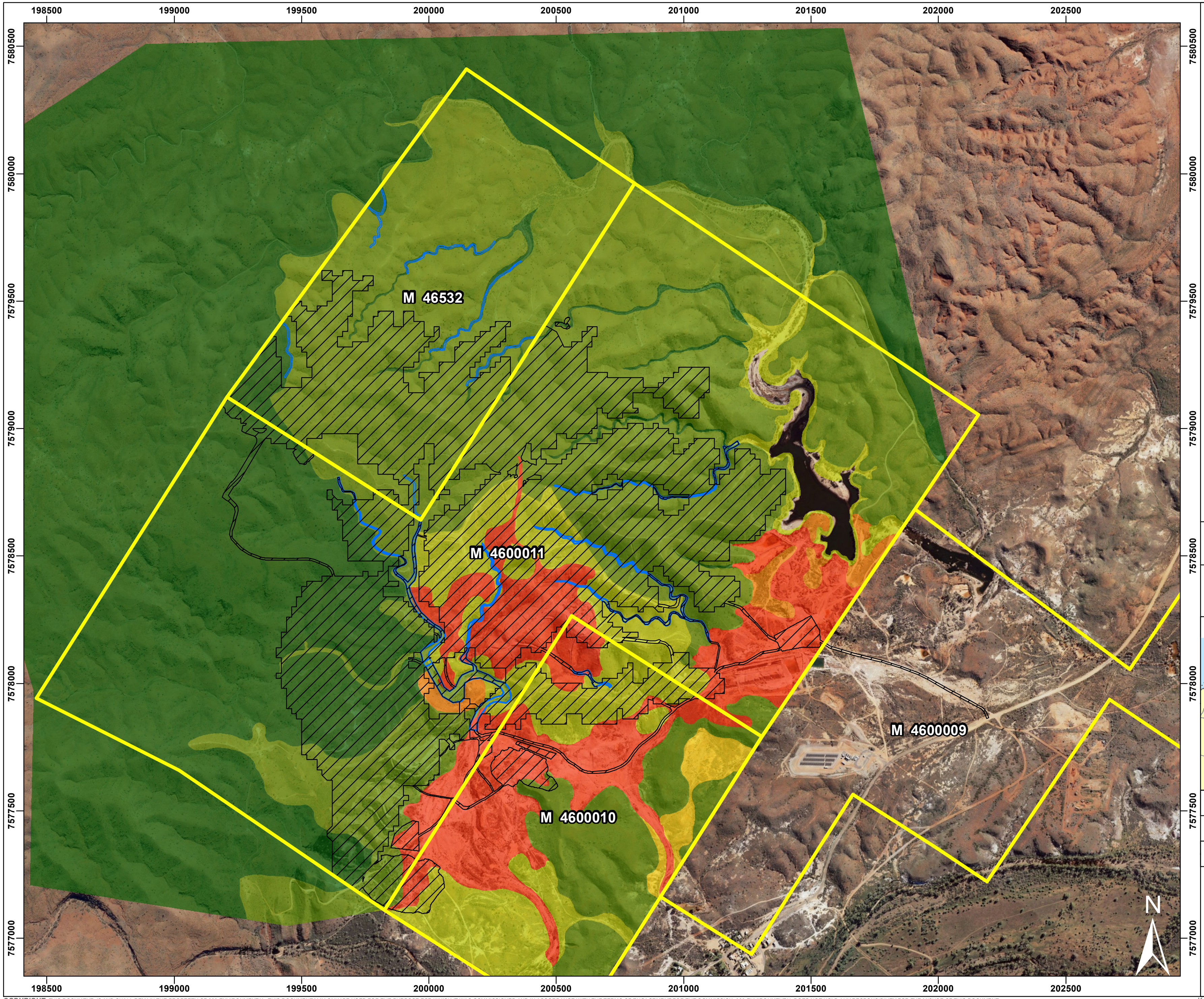

Legend

- Mining Lease
- Disturbance Area
- Approved Alluvials Creekline Disturbance Area

Vegetation Condition

- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Completely Degraded

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
- VEGETATION CONDITIONS BASED ON SURVEY BY MMWC 2014
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2017 (© Western Australian Land Information Authority 2017)

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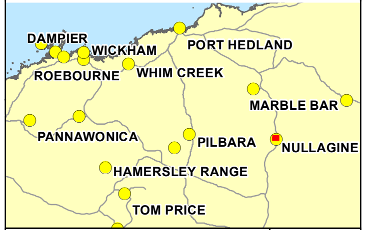

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Figure 4
Vegetation Condition

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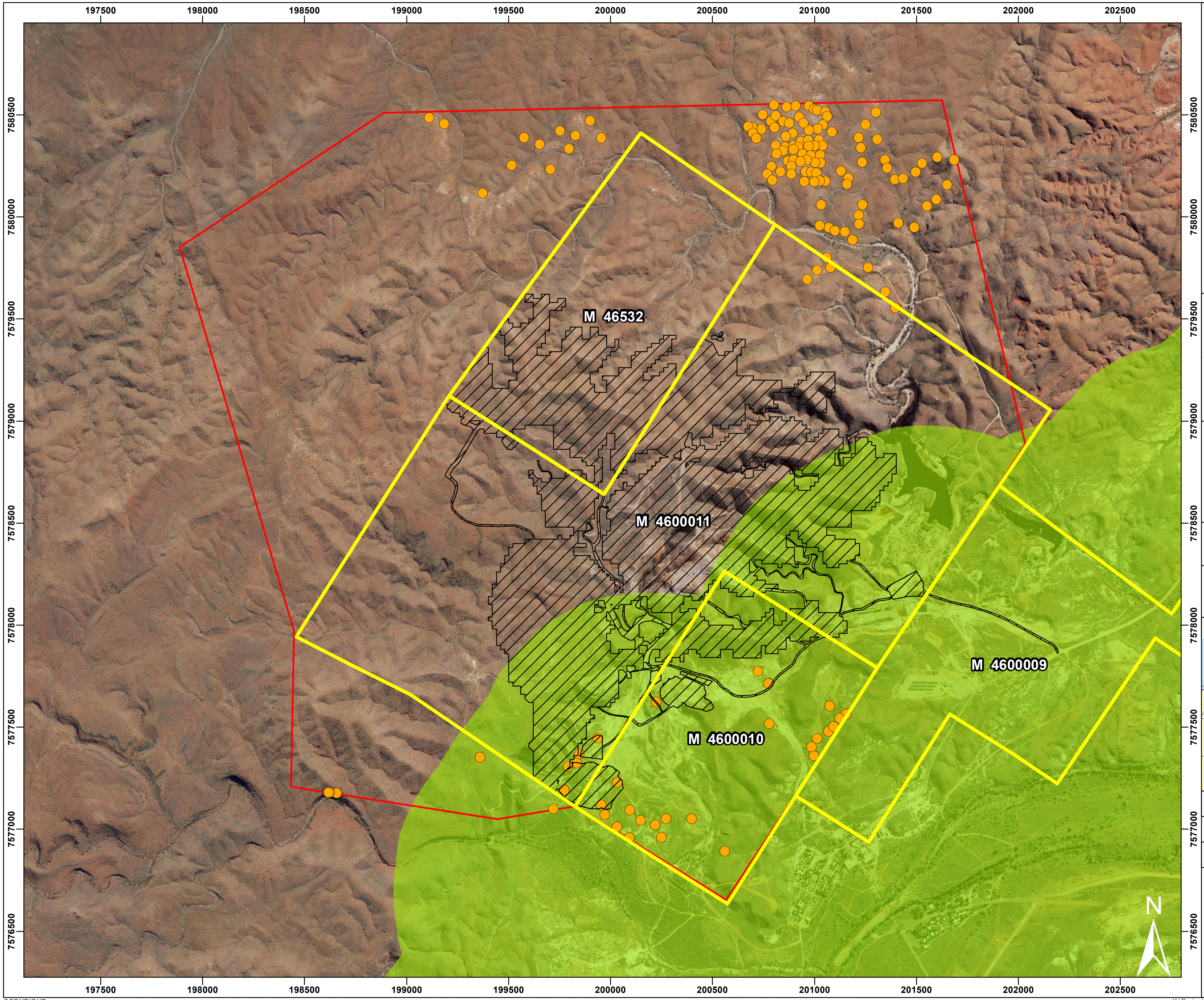


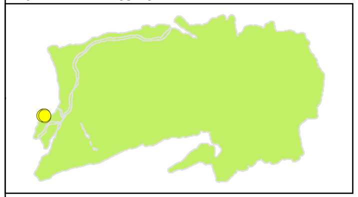
Legend

- Mining Lease
- Disturbance Area
- Flora and Fauna Survey Area
- Priority Flora

TECs and PECs

- PEC: Mosquito Land System (Priority 3) Extent and Buffer: Stony saline clay plains of the Mosquito Land System

Full PEC Extent



- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
- VEGETATION CONDITIONS BASED ON SURVEY BY MMWC 2014
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LOCALITY MAP

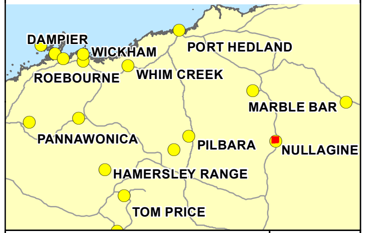

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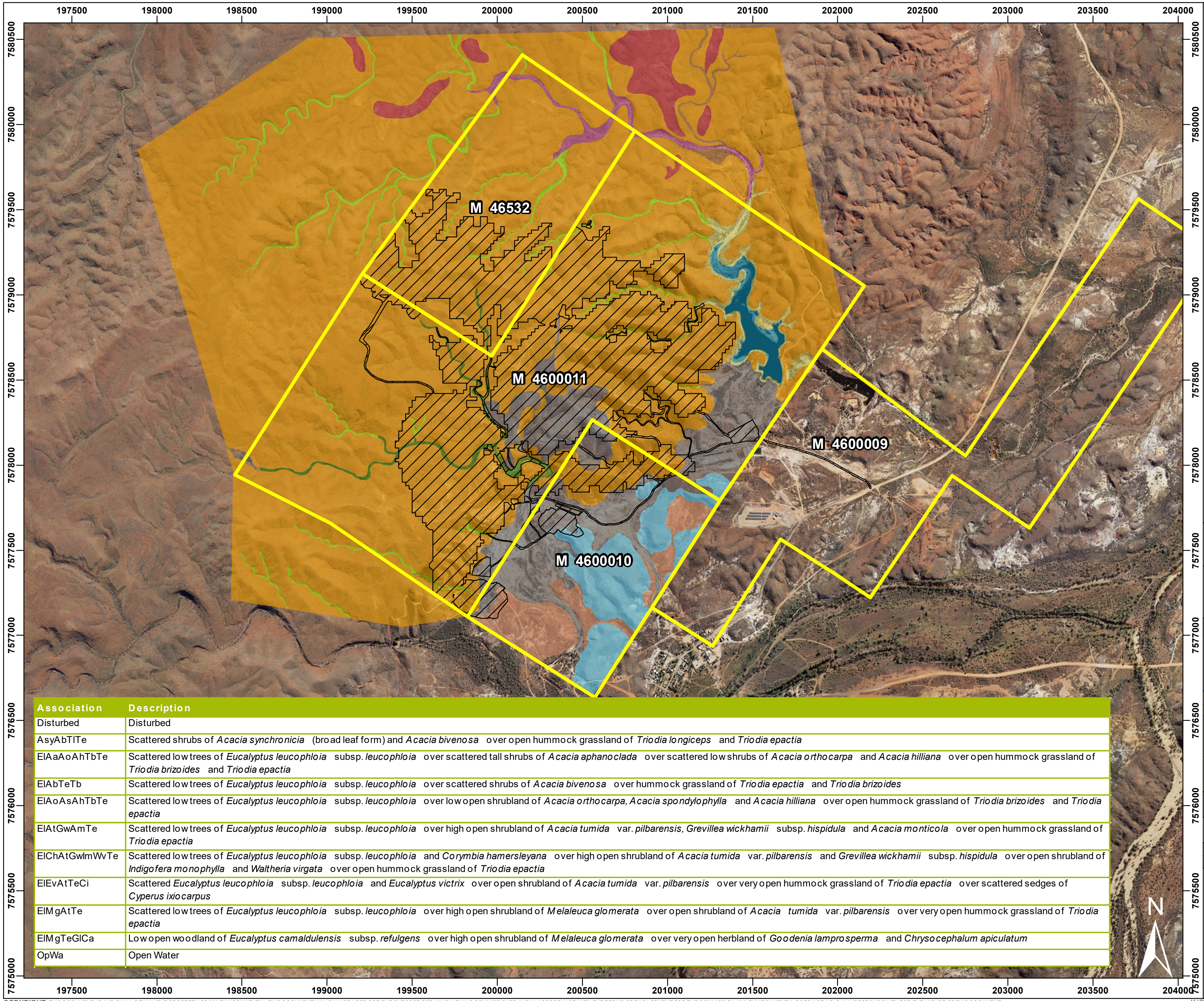
Figure 5
TECs, PECs and Flora Records

K:\Projects\9.0 APP\3590 Beatons Creek\3590 F5 TEC PEC and Flora Records.mxd



Association	Description
Disturbed	Disturbed
AsyAbTlTe	Scattered shrubs of *Acacia synchronicia* (broad leaf form) and *Acacia bivenosa* over open hummock grassland of *Triodia longiceps* and *Triodia epactia*
ElAaAoAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered tall shrubs of *Acacia aphanoclada* over scattered low shrubs of *Acacia orthocarpa* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*
ElAbTeTb	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered shrubs of *Acacia bivenosa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*
ElAoAsAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia orthocarpa, Acacia spondylophylla* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*
ElAtGwAmTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* subsp. *hispidula* and *Acacia monticola* over open hummock grassland of *Triodia epactia*
ElChAtGwImWvTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over high open shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Indigofera monophylla* and *Waltheria virgata* over open hummock grassland of *Triodia epactia*
ElEvAtTeCi	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Eucalyptus victrix* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* over scattered sedges of *Cyperus ixiocarpus*
ElMgAtTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Melaleuca glomerata* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*
ElMgTeGlCa	Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high open shrubland of *Melaleuca glomerata* over very open herbland of *Goodenia lamprosperma* and *Chrysocephalum apiculatum*
OpWa	Open Water

Legend

- Mining Lease
- Disturbance Area

Vegetation Associations

- AsyAbTlTe
- Disturbed
- ElAaAoAhTbTe
- ElAbTeTb
- ElAoAsAhTbTe
- ElAtGwAmTe
- ElChAtGwImWvTe
- ElEvAtTeCi
- ElMgAtTe
- ElMgTeGlCa
- OpWa

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
- VEGETATION CONDITIONS BASED ON SURVEY BY MMWC 2014
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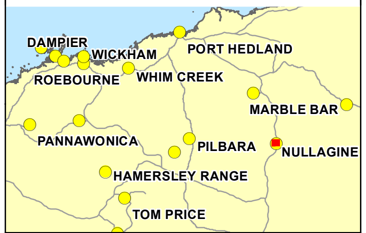

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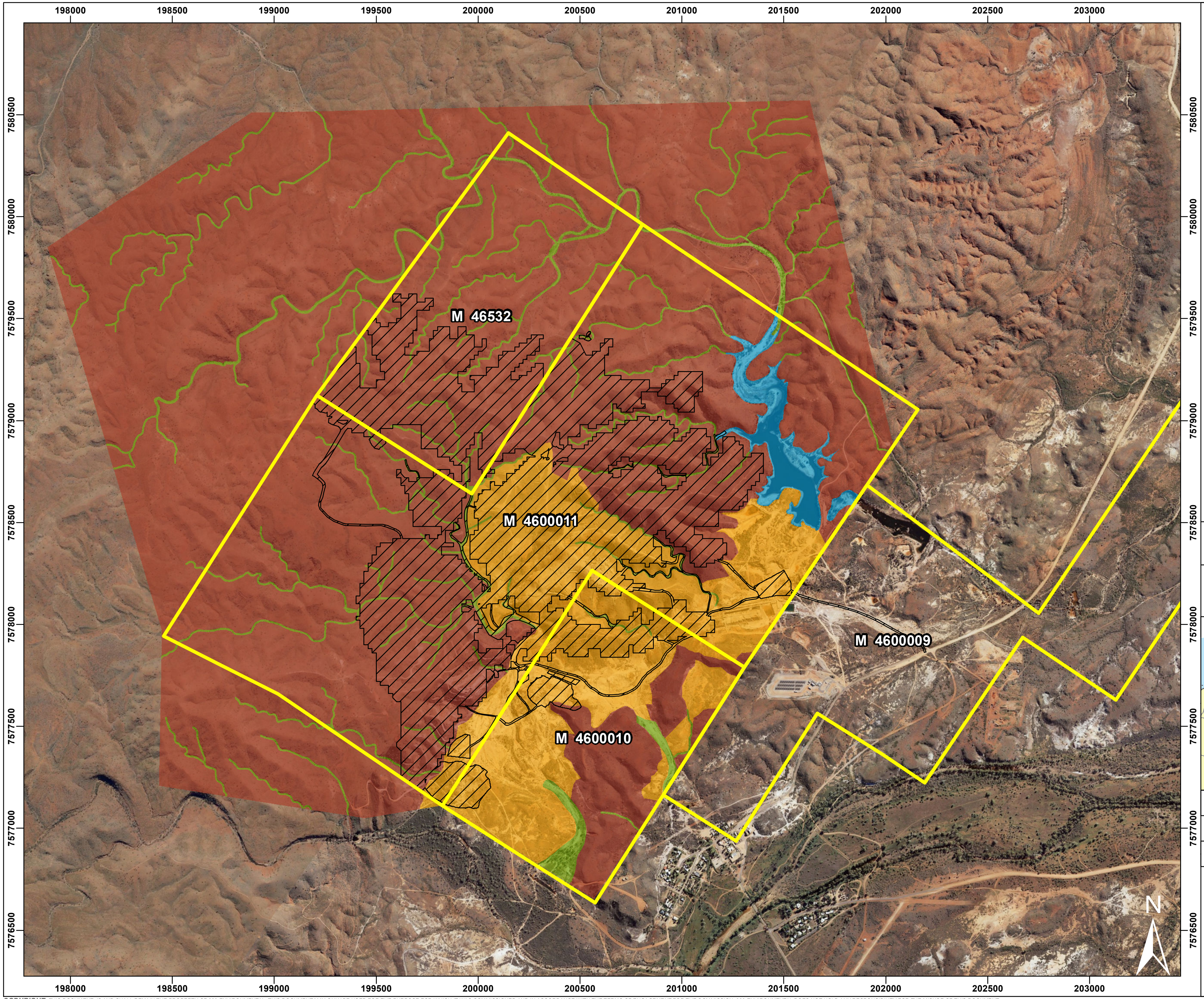
Figure 6
Surveyed Vegetation Associations

K:\Projects\9.0 APP\3590 Beatons Creek\3590 F6 Vegetation Associations.mxd



Legend

- Mining Lease
- Disturbance Area

Fauna Habitats

- Dam
- Degraded Mining Area
- Drainage Area
- Hill

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
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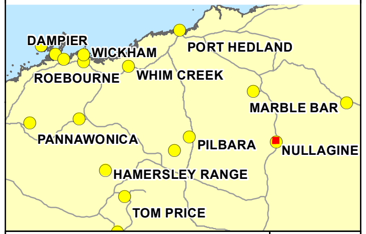

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Figure 7

Fauna Habitats

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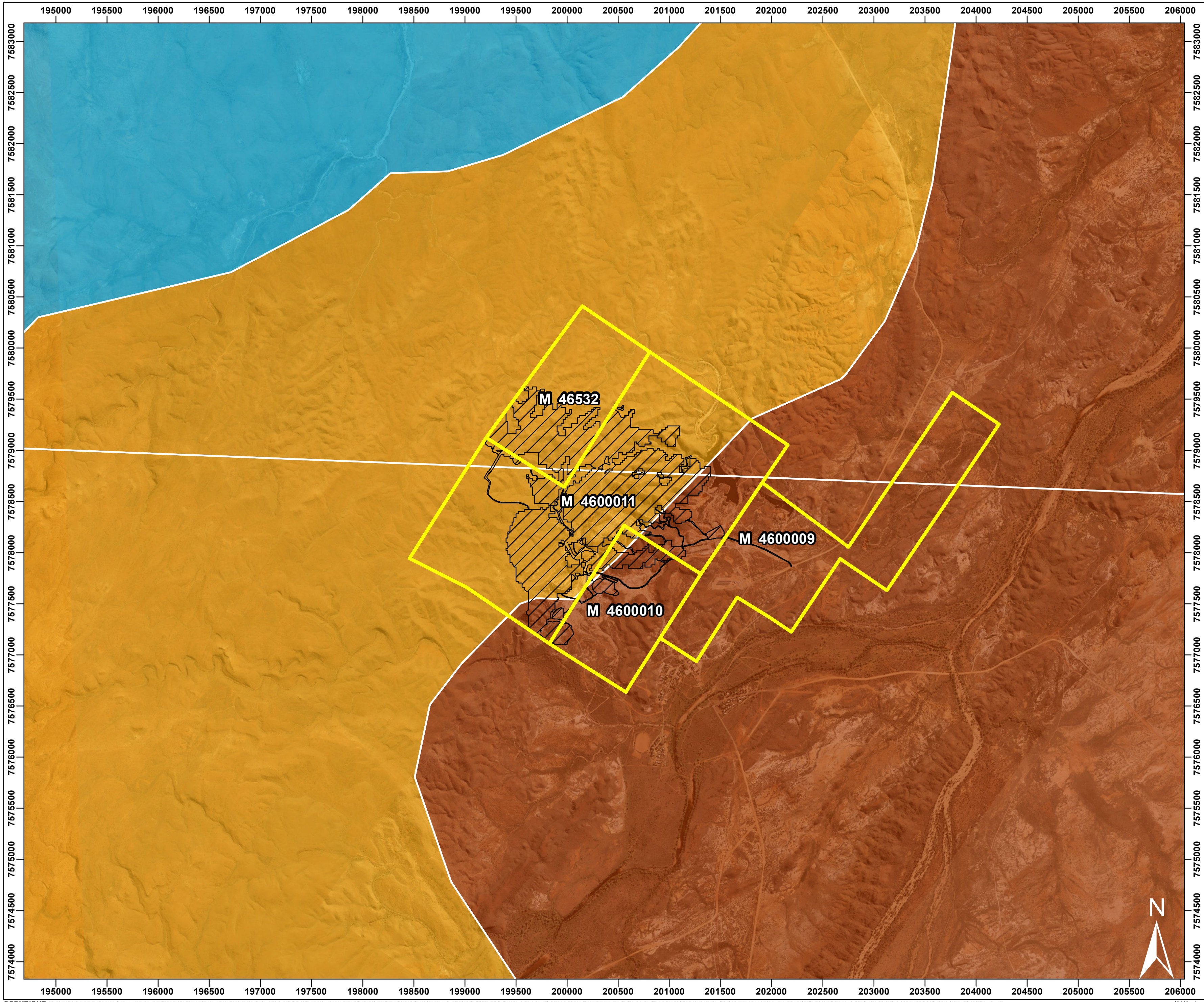

Legend

Mining Lease

Disturbance Area

Shepherd Vegetation Associations

CHICHESTER_93: Hummock grasslands, shrub steppe; kanji over soft spinifex

CHICHESTER_173: Hummock grasslands, shrub steppe; kanji over soft spinifex and *Triodia wiseana* on basal

CHICHESTER_190: Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* and *A. trachycarpa* over hard spinifex, *Triodia wiseana*, Very poor rocky country on gneiss

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
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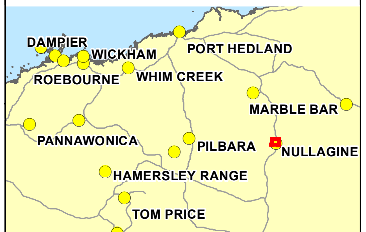

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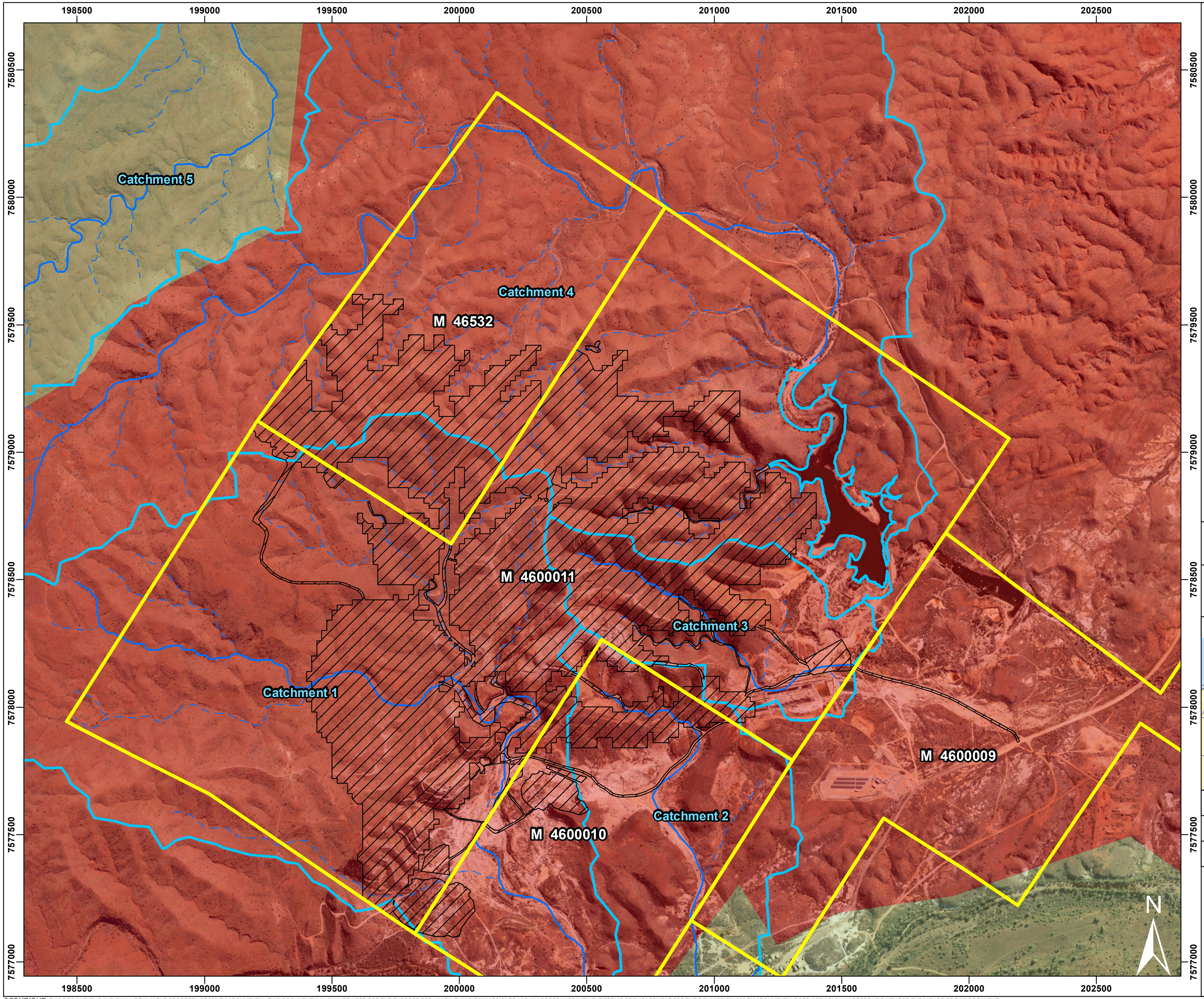
Figure 8

Broad Vegetation Association

K:\Projects\9.0 APP\3590 Beatons Creek\3590 F8 Broad Vegetation Association.mxd



Legend

- Mining Lease
- Disturbance Area
- Catchment Boundaries
- Major Streams
- Minor Streams

Public Drinking Water Source Areas

- Priority 1
- Priority 3

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
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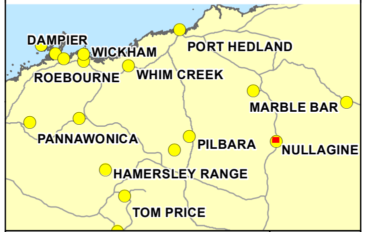

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Figure 9
Local Hydrology

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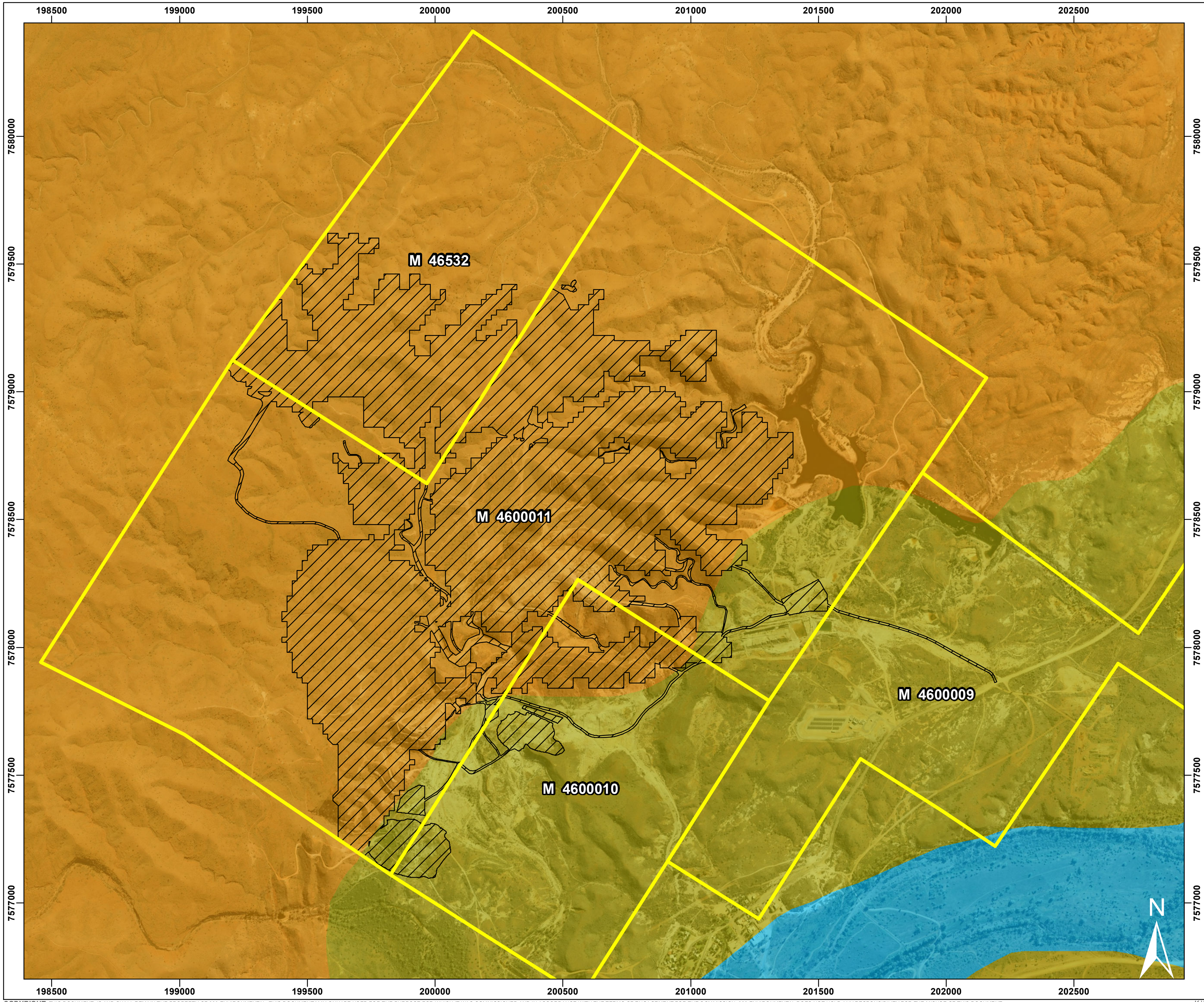

Legend

Mining Lease

Disturbance Area

Soil Descriptions

Mostly stony soils (WA Soil Group 203), some red shallow loams (WA Soil Group 522), rarely red shallow sands (WA Soil Group 423) and river bed soils in drainage channels (WA Soil Group 705)

Predominantly stony soils with red shallow loams (WA Soil Group 203 and 522), some shallow red/brown non-cracking clays (WA Soil Group 622) and river bed soils in drainage channels (WA Soil Group 705)

Predominantly deep red/brown non-cracking clays and red loamy earths (WA Soil Group 622 and 544), some river bed soils in drainage channels (WA Soil Group 705), some mostly red deep sands with red sandy earths (WA Soil Group 445, 463)

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- CONCEPTUAL LAYOUT CREATED FROM CLEARING TIMELINE (MAX CLEARING FOOTPRINT; NOVO RESOURCES APRIL 2016)
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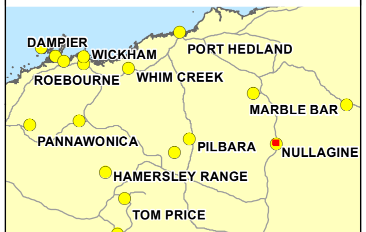

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Figure 10

Soil and Lan Systems

K:\Projects\9.0 APP\3590 Beatons Creek\3590 F10 Soil and Lan Systems.mxd

APPENDIX A

Flora and Vegetation Assessment

MMWC Environmental PTY LTD

ENVIRONMENTAL MANAGEMENT & OUTCOMES FOR MINING & DEVELOPMENT

BEATONS CREEK GOLD PROJECT

FLORA AND VEGETATION ASSESSMENT

March 2015

BEATONS CREEK GOLD PROJECT

FLORA AND VEGETATION ASSESSMENT

Prepared for

Novo Resources

Prepared by

MMWC Environmental PTY LTD

ENVIRONMENTAL MANAGEMENT & OUTCOMES FOR MINING & DEVELOPMENT

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Prepared	Date	Status	Version	Reviewed
Bridget Watkins	23/02/2015	Draft	V1	Internal & FJ, HA
Bridget Watkins	12/03/2015	Draft	V2	QH
	16/06/2015	Final	V2	QH

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APPENDIX G FLORA TAXA INVENTORY

APPENDIX H MATRIX OF FLORA RECORDED WITHIN EACH QUADRAT AND RELEVÉ

APPENDIX I LOCATION OF CONSERVATION SIGNIFICANT FLORA

APPENDIX J STATISTICAL ANALYSIS DENDROGRAM

PERMITS

The flora survey was conducted under the following licences issued by the Department of Parks and Wildlife; Licence to take flora for scientific or other prescribed purposes: SL010451 issued to Bridget Watkins and SL010691 issued to Hayden Ajduk.

Executive Summary

MMWC Environmental was commissioned by Novo Resources, in August 2014, to undertake a single season Level 2 flora and vegetation assessment of the Beatons Creek Gold Project. The southern outer boundary of the survey area is located approximately 400 m north west of Nullagine in Western Australia and comprises a total of 1172.17 ha. Within the survey area is a man-made dam (constructed in the 1980's) which comprises approximately 10.17 ha; therefore bringing the total land area to 1162 ha. The survey area is approximately twice the size of the current proposed disturbance footprint for the project.

The purpose of the assessment was to provide baseline results to support future impact assessment. The field survey was undertaken from the 2nd September 2014 to 9th September 2014 by two appropriately experienced botanists. A total of 173 taxa were recorded from 91 genera and 43 families during the survey which involved 41 quadrats, 10 relevés and numerous opportunistic collections.

The desktop assessment and database search results indicated one Threatened (*Lepidium catapycnon*) and 26 Priority Flora previously recorded within the vicinity of the survey area. No species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), or gazetted as Threatened Flora under the *Wildlife Conservation Act 1950* (WA) were recorded during the survey. As *Lepidium catapycnon* (Threatened) had previously been recorded in the vicinity, the survey area was thoroughly searched for any occurrence of the species on site with no individuals recorded.

Three species of Priority flora were recorded during the survey: *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1). *Acacia aphanoclada* and *Acacia cyperophylla* var. *omearana* have previously been recorded in the Nullagine area. However, the confirmed record of *Ptilotus wilsonii* is the first official record of the species in the Pilbara bioregion and represents a range extension of approximately 200 km from previous locations near the Rudall River National Park, east of Nullagine.

Of the remaining species presented in the database searches, two were considered likely to occur in the survey area: *Atriplex spinulosa* (Priority 1) and *Indigofera ixocarpa* (Priority 2).

Three species of introduced flora were recorded in the survey area: **Aerva javanica*, **Calotropis procera* and **Cenchrus ciliaris*. None of these species are listed as Weeds of National Significance by the Australian Government. One of these three species (**Calotropis procera*) is listed as a Declared Plant under the *Biosecurity and Agriculture Management Act 2013*.

Eleven vegetation associations were mapped in the survey area. None of the vegetation associations are listed as a Threatened Ecological Community under the *Environment Protection and Biodiversity Conservation Act 1999,* as an Environmentally Sensitive Area under the *Environmental Protection Act 1986* or as a Priority Ecological Community by the Department of Parks and Wildlife.

However, the buffer zone of the Priority 3 Ecological Community Mosquito Land System extends into the survey area. In addition, the entire survey area is situated within a Schedule 1 area, as recognised under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. The Schedule 1 area encompasses the Nullagine Water Reserve.

There are large areas of disturbance throughout the survey area remaining from historical exploration and prospecting activities. However, the majority of the survey area was considered to be in Excellent condition with large areas of the hills surrounding the centre of the survey area undisturbed. The primary resource area overlaps the previously disturbed areas.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

MMWC Environmental (MEC) was commissioned by Novo Resources in August 2014 to undertake a single season Level 2 Flora and Vegetation assessment for the Beatons Creek Gold Project (the survey area; Figure 1). The nearest point of the outer boundary of the survey area is located approximately 400 m north west of Nullagine in Western Australia. The survey area comprises a total area of 1172.17 ha. Within the survey area is a man-made dam which covers approximately 10.17 ha; therefore, bringing the total land area to 1162 ha.

Novo Resources propose to develop a gold mine operation targeting approximately the top 20 m of rock along the hilltops throughout the centre of the survey area. Surrounding areas were surveyed for infrastructure location options. The purpose of the assessment was to provide baseline information for future environmental impact assessment.

1.2 OBJECTIVES

The objectives of the flora and vegetation assessment were to:

- Conduct a flora and vegetation database search and literature review;
- Undertake a field survey to assess the flora and vegetation within the survey area;
- Document, describe and map the vegetation associations present;
- Compile an inventory of vascular plant species present;
- Undertake targeted searches and map locations of Threatened and/or Priority flora;
- Record the occurrence of introduced plant species;
- Assess and map vegetation condition;
- Assess the potential impact of clearing on any significant vegetation or flora;
- Assess the proposed development against the ten Native Vegetation Clearing Principles as detailed in Schedule 5.0 of the *Environmental Protection Act 1986* (as relevant to the flora and vegetation of the survey area).

1.3 LOCATION

The survey area comprises a total area of 1172.17 ha. Within the survey area is a man-made dam which comprises approximately 10.17 ha; therefore bringing the total land area to 1162 ha. The southern outer boundary of the survey area is located approximately 400 m north west of Nullagine in Western Australia (Figure 1). The survey area is approximately 4.5 km in length and 4 km in width.

2 EXISTING ENVIRONMENT

2.1 CLIMATE

The survey area is in the Pilbara region of Western Australia. The Pilbara has an arid-tropical climate with two distinct seasons, a hot and wet summer from October to April and a mild winter from May to September. Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland. Winter rainfall is commonly the result of cold fronts moving north-easterly across the State (Bureau of Meteorology (BoM) 2014).

The nearest public climate data is available from the BoM Marble Bar and Noreena Downs Station weather stations located 85 km north-north-west and 45 km south, respectively, of the survey area. Long term rainfall data has been recorded at Noreena Downs since 1911. More reliable data for temperatures and recent rainfall has been recorded at Marble Bar, and as such, results have been drawn from both locations rather than a single location.

The average annual maximum temperature for Marble Bar is 35°C and the average annual minimum temperature is 20°C. In summer, mean monthly maximum temperatures reach 41.5°C, and in winter mean monthly minimum temperatures fall to 12°C. Noreena Downs have recorded an average annual rainfall of 325 mm from 1911-2014. While rainfall is often sporadic, and can occur throughout the year, Noreena Downs receives 71% of its total annual rainfall during the wet season from December to March (BoM 2014) (Figure 2).

For the three months preceding the survey (June 2014 to August 2014), Marble Bar received 51 mm of rainfall, compared with the long-term average rainfall of 35.6 mm (1911-2014) for the same period. This constitutes 15.4 mm and 43% more than the long term average.

Rainfall for the 12 months before the survey (September 2013 to August 2014) at Marble Bar was 547 mm compared with 325 mm for the long-term average (1911-2014) for the same period. This constitutes 222 mm and 70% more than the long term average.

In addition, it should be recognised that Novo Resources installed a weather station on site in early 2015 which will provide immediate publicly available weather data. This data is likely to be useful for future reference rather than relying on results from distant locations.

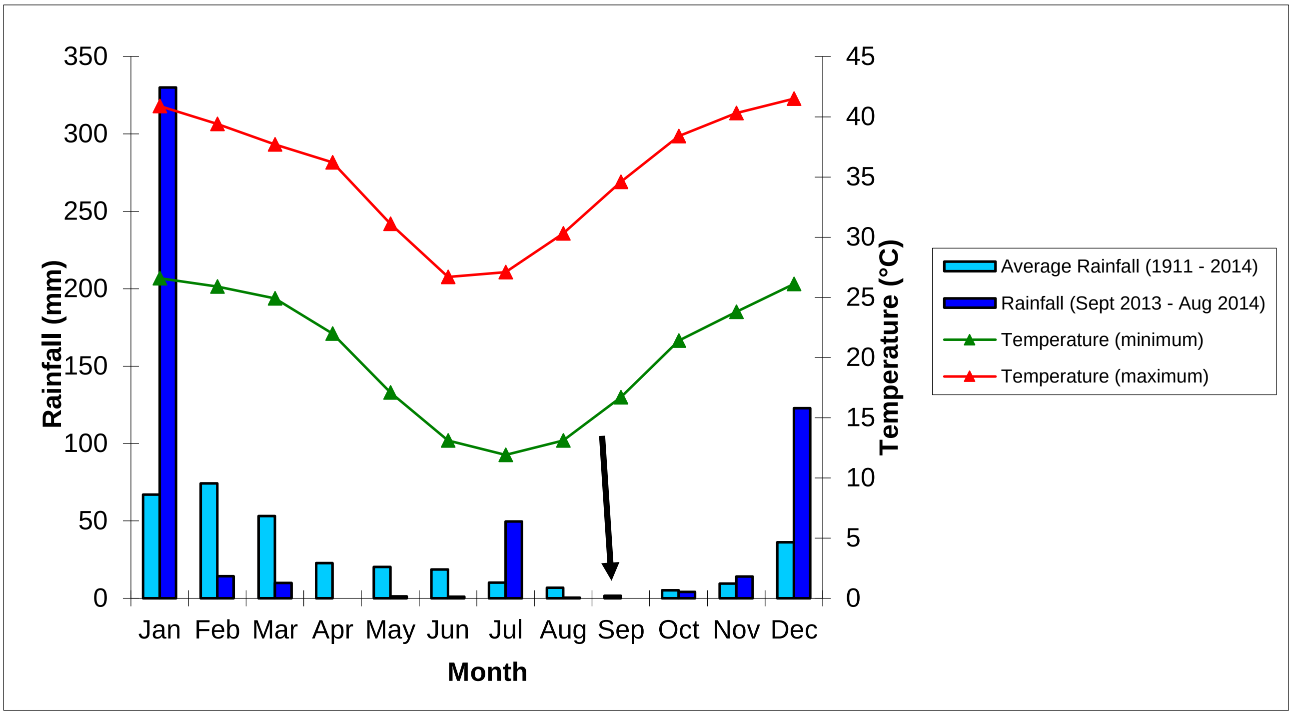

Figure 2: Average long-term (1911-2014) Rainfall for Noreena Downs Station and 2013/14 Monthly Rainfall and Average Maximum and Minimum Temperatures (2000-2014) for Marble Bar (BoM 2014). Arrow indicates survey time.

2.2 Geology and Soils

The survey area is dominated by one main geological formation based on mapping by the Geological Survey of Western Australia (2007) captured at a scale of 1:250,000 (Figure 3): Hardey Formation – sediment and felsic volcanic rocks; local intrusive rocks. A single dolerite dyke intersects the survey area inside the north eastern boundary and numerous exposed fault lines dissect the west and south regions of the survey area.

The soils of the survey area were mapped by Tille (2006). The survey area is situated in the Fortescue Province, in the Nullagine Hills Zone. The Nullagine Hills Zone is characterised by:

> *"Hills and ranges (with some stony plains) on volcanic and sedimentary rocks of the Pilbara Craton (including the Hamersley Basin). Stony soils with red shallow loams and sands. Spinifex grasslands with kanji and snappy gum. Located in the north eastern Pilbara around Marble Bar and Nullagine* (Tille 2006)."

2.3 Landforms and Hydrology

The survey area is situated across an area of steep to undulating hills with broad to incised gullies intersecting the hills throughout. A dammed water reservoir is located near the eastern boundary. This dam was constructed by Nullagine locals in the 1980's and is not used as a drinking water source but is used recreationally for swimming (*pers. comm*. Bill Edwards, Nullagine resident).

A large area in the south eastern portion of the survey area has been previously disturbed with historical exploration and prospecting activities. The primary water flow in the northern portion of the survey area flows west to east into a channel that flows south into the reservoir. Surface water in the southern third of the survey area flows south towards the town of Nullagine. Beatons Creek is situated immediately south of the southern boundary of the survey area, flowing east into the Nullagine River.

2.4 Biogeographic Regionalisation for Australia

The Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical/ geological attributes. These bioregions are subdivided into 419 subregions, as part of a refinement of the IBRA framework (DoE 2012).

The survey area is located across the Chichester subregion (PIL1) of the Pilbara bioregion (DoE 2012). The Chichester subregion is characterised by Archaean granite and basalt plains with a shrub steppe of *Acacia inaequilatera* over *Triodia wiseana* hummock grassland and *Eucalyptus leucophloia* tree steppe on the ranges (Kendrick and McKenzie 2001). This subregion comprises the entirety of the survey area.

2.5 Landsytems

Land system mapping is based on regional patterns in topography, soils and vegetation. The Pilbara bioregion, as defined by IBRA (DoE 2012), covers an area of approximately 178,088 km^2. Land system mapping classifies the Pilbara into 106 land systems captured across three studies (Payne, Mitchell & Holman 1988; Payne & Tille 1992; van Vreeswyk, Payne, Leighton & Hennig 2004).

The survey area occurs in association with two land systems: Capricorn and Mosquito Land Systems (Table 1; Figure 4):

- Capricorn - Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grassland; and
- Mosquito - Stony plains and prominent ridges of schist and other metamorphic rocks supporting hard spinifex grasslands.

Table 1: Land Systems of the Survey Area

Land System	Area of Land System in the Pilbara Bioregion		Area of Land System in the Survey Area		Extent of Total Land System Represented within the Survey Area
	Area (km²)	% of Pilbara Bioregion	Area (km²)	% of Survey Area	
Capricorn	5,296 km^2	2.9%	10.3 km^2	87.6%	0.19%
Mosquito	1,840 km^2	1%	1.46 km^2	12.4%	0.08%

2.6 Broad Vegetation Mapping

Vegetation mapping of the Pilbara region was conducted on a broad scale (1:1,000,000) by Beard (1975). Shepherd *et al.* (2001) re-assessed the vegetation mapping originally produced by Beard (1975) in order to integrate changes including clearing which had taken place and separating some of the broad vegetation units into smaller units.

There are two Beard (1975) / Shepherd *et al.* (2001) vegetation units described within the survey area (Table 2). Beard (1975) units are represented within the square brackets. The pre-European and current remaining extents of each vegetation unit have been compiled (Government of Western Australia 2013). However, some calculations of each vegetation unit are not provided and, as such, results have not been provided in Table 2 in this instance.

- 173 [a2Sr t1,3Hi] - Hummock grasslands, shrub steppe; kanji over soft spinifex & *Triodia wiseana* on basalt; and
- 190 [a6, 7Sb t3Hi] - Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* & *A. trachycarpa* over hard spinifex, *Triodia wiseana*, Very poor rocky country on gneiss.

Table 2: Broad Vegetation Types and their State and Regional Representation (Government of Western Australia 2013)

Vegetation Type	Pre-European Area (ha)	Current Extent Remaining (ha)	Current Extent Remaining (%)	Current Extent (%) in IUCN Class I - IV Reserves (proportion of current extent)	EPA Clearing Threshold Level
Vegetation Types – in Western Australia					
173 [a2Sr t1,3Hi]	1,753,104.09	1,748,260.83	99.72	7.51	Above the 30% threshold
190 [a6, 7Sb t3Hi]	169,199.69	169,050.97	99.91	Not provided	Above the 30% threshold
Vegetation Types – in the Pilbara bioregion					
173 [a2Sr t1,3Hi]	1,752,520.89	1,747,677.63	99.72	7.51	Above the 30% threshold
190 [a6, 7Sb t3Hi]	169,199.69	169,050.97	99.91	Not provided	Above the 30% threshold
Vegetation Types – in the Chichester subregion					
173 [a2Sr t1,3Hi]	1,744,029.52	1,739,189.59	99.72	7.54	Above the 30% threshold
190 [a6, 7Sb t3Hi]	169,199.69	169,050.97	99.91	Not provided	Above the 30% threshold

2.7 CONSERVATION ESTATE

2.7.1 National Parks, Nature Reserves and other Protected Areas

The closest conservation estate managed by the Department of Parks and Wildlife (DPaW) is Karijini National Park, which is approximately 146 km south west of the survey area. The nearest Environmentally Sensitive Area (ESA) is the Fortescue Marsh, approximately 80 km south of the survey area.

2.7.2 Environmentally Sensitive Areas

Section 51B of the EP Act allows the Minister to declare an ESA. Once declared, the exemptions to clear native vegetation under the regulations do not apply in these areas. TECs and areas within 50 m of any Threatened Flora constitute ESAs. However, a number of other areas of environmental significance are also listed. Current declared ESAs are listed in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*.

There are no ESAs within or adjacent to the survey area. The nearest ESA is the Fortescue Marsh, approximately 80 km south of the survey area.

In addition, there are no TECs recorded within 50 km of the survey area. However, the entire survey area is situated within a Schedule 1 Area (as recognised under the *Environmental Protection [Clearing of Native Vegetation] Regulations 2004*) which is approximately 18.5 km x 10.3 km with Nullagine near the centre (DER 2014). The Schedule 1 area encompasses the Nullagine Water Reserve (Water and Rivers Commission 1999).

3 METHODS

The field survey was conducted from the 2nd to the 9th of September 2014, with 14 person-days invested in the field survey. The survey was consistent with a single season Level 2 flora and vegetation survey per the Environmental Protection Authority (EPA) requirements for environmental surveying and reporting for flora and vegetation in Western Australia, as set out in the following documents:

- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No.2* (EPA 2000);
- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002); and
- *EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51* (EPA 2004).

3.1 DESKTOP ASSESSMENT

The desktop assessment provided background information on the flora and vegetation of the survey area. A request for database searches was submitted to the DPaW in August 2014. The following databases were searched from coordinates 199990 mE, 7578881 mN Zone 51K:

- DPaW Threatened and Priority Flora database, 50 km radial search (DPaW 2014a);
- DPaW Threatened and Priority Ecological Community database, 50 km radial search (DPaW 2014b)
- DPaW NatureMap Flora search, 40 km radial search (DPaW 2014c); and
- EPBC Protected Matters Search Tool, 50 km radial search (DoE 2014).

In addition, previously conducted, publicly available flora and vegetation assessments from the vicinity of the survey area were reviewed (Plant Ecology Consulting 2013; and Mattiske Consulting 2010).

3.2 FLORA AND VEGETATION

The field survey was conducted across an area approximately twice the size of the proposed disturbance footprint.

3.2.1 Flora and Vegetation Assessment

The survey included the assessment of 51 sites, consisting of 41 quadrats and 10 relevés (Figure 6). Quadrats are vegetation survey plots which are accurately measured out as 50 x 50 m (or an area equivalent to 2500 m^2) and marked at the north-west corner using a handheld Garmin GPS unit. Relevés are 'unmarked quadrats', where a centre point is marked and an area equivalent to that of a quadrat is visually approximated around this point for the purpose of estimating species composition and cover.

The information recorded at each quadrat included landscape features, surface soil colour and texture, bare ground, litter cover, disturbance, fire age, aspect and vegetation condition. Each species of plant at each quadrat was recorded, including information on height and percentage cover.

3.2.2 Targeted Searches

Habitats and locations considered likely to support conservation significant flora were targeted for searches. Further opportunistic collections focused on the location of taxa not recorded in the quadrats and on locations of introduced species. For each population of significant flora identified the following was recorded:

- Co-ordinate locations (using handheld GPS units);
- Description of vegetation association present;
- Estimation of population size; and
- Photograph of plant *in situ*, where possible.

The survey area comprises habitat that could support the Threatened flora species *Lepidium catapycnon*. As such, the hill tops and hill slopes throughout the survey area were thoroughly searched to assess for the occurrence of this species.

Parallel traverses were conducted on foot (approximately 50 m intervals) throughout the main population of *Acacia aphanoclada* (Priority 1) recorded in the north of the survey area in order to assess the size and extent of the population.

3.2.3 Taxonomy and Nomenclature

Where confirmed identification of plant taxa was not possible in the field, specimens were collected systematically for later identification utilising MEC's in house herbarium, identification keys, relevant taxonomic papers published in journals and resources of the Western Australian Herbarium (WAH) were also utilised.

The species list was checked against FloraBase (WAH 2014) to determine the species' conservation status. Threatened and Priority Flora were verified against the *EPBC Act* listing of threatened species to determine federal listing. The definitions of the conservation categories for Threatened and Priority flora are presented in Appendix A. The definitions of the conservation categories for Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) are presented in Appendix B.

Introduced species were checked against the DPaW Weed Prioritisation Process – Pilbara Weed Assessment List (DPaW 2013), to determine their ranking in terms of environmental impact, the *Biosecurity and Agriculture Management Act 2013* (*BAM Act*) Declared Plants list was consulted to determine if any are Declared Plants, and the Weeds of National Significance (WONS) list to determine any WONS (Commonwealth of Australia 2013). The Weed Prioritisation Process and Declared plant categories are defined in Appendix C.

3.2.4 Vegetation Association and Condition Mapping

The vegetation associations were described based on their structure and species composition, as defined by quadrat data, and field observations. Vegetation was mapped in the field using handheld GPS (Garmin) units and high-resolution aerial photographs, then digitised as map figures using GIS software. Vegetation associations were defined using the classification system defined by Specht (1970) with modification by Aplin (1979) and Trudgen (1988) (Appendix D). This classification system was used in order to allow cover of species with less than two per cent cover to be considered. This system allows for the 'low cover of many strata in the vegetation of more arid areas' (Trudgen 2002).

Statistical analysis was utilised to assist in defining the vegetation associations. Statistical analysis was conducted on the quadrat results using Primer-E version 6.1.5. Quadrat percentage cover was transformed (square root). Other transformations were considered (presence/absence and fourth root); however, square root was selected as being the most appropriate. A similarity matrix based on Bray-Curtis similarities was calculated and a dendrogram was produced using hierarchical agglomerative cluster analysis.

Once the vegetation associations were determined, they were checked against the listing of Federal and State TECs and State PECs. Vegetation condition was mapped in the field using handheld GPS units and high-resolution aerial photographs, then digitised as map figures using GIS software. Vegetation condition was assessed based on Trudgen (1991) (Appendix E).

3.3 Survey Limitations and Constraints

It is important to note the specific constraints imposed on surveys. Constraints are often difficult to predict, as is the extent to which they influence survey effort. Survey constraints are usually associated with timing of the survey, weather, season, accessibility and coverage of the survey area. The limitations and constraints related to the survey of the Beatons Creek survey area are addressed in Table 3.

Table 3: Potential Limitations and Constraints Associated with the Flora and Vegetation Survey

Potential Limitation	Impact on Survey	Comment
Scope (i.e. life forms targeted during survey)	No impact	Vascular flora within the survey area was the focus of this survey. The vascular flora of the survey area was thoroughly assessed through 41 quadrats, 10 relevés and comprehensive opportunistic collections across the entire survey area.
Experience	No impact	Survey personnel (Bridget Watkins and Hayden Ajduk) are thoroughly experienced in collecting and identifying Pilbara flora both in the field and using herbarium resources. Experienced taxonomists (Malcolm Trudgen and Rob Davis) were consulted to assist in the identification of specimens as required. In addition, all Priority listed flora presented in the results were confirmed by Malcolm Trudgen and/or Rob Davis.
Access restrictions	No impact	All areas were accessible by vehicle or on foot.

Potential Limitation	Impact on Survey	Comment
Adequate survey area coverage	No impact	All areas of the survey area were accessed either by vehicle or on foot. The majority of the survey area was accessed on foot and it is considered the relevés and quadrats assessed provided adequate coverage of the vegetation associations present within the survey area. The survey length was sufficient to allow assessment of the entire survey area.
Seasonality	Moderate impact	The survey timing and season was considered to be acceptable with Marble Bar (85 km north of the survey area) recording above average rainfall in the three months prior to the survey (51 mm compared to long term average of 35 mm for same period). This rainfall extended the flowering season and the occurrence of annuals on site. However, it is likely more annual species could be recorded if a survey is conducted following a cyclonic rainfall event. It is recognised that cyclonic or other significant rainfall events are very unreliable in this region and that waiting for such an event before conducting a survey is not suitable. As a perennial shrub, *Lepidium catapycnon* (Threatened) would have been present during this survey period. The only annual species considered likely to occur in the survey area was *Atriplex spinulosa* (Priority 1).
Sources of information	No impact	Comprehensive background information on the flora and vegetation of the Nullagine area was compiled prior to the survey from previously conducted flora and vegetation reports and database search results (DPaW 2014a).
Disturbances	Low impact	Some areas showed indication of fire, however there were no significant areas of recent fire which restricted the botanist's ability to assess the flora and vegetation on site. Large areas in the south of the survey area are disturbed from historical exploration and prospecting activities and there are numerous tracks across the hill ridges throughout the centre of the survey area. The dam is man-made, however it has allowed the creation of a wetland.
Resources	No impact	Adequate resources were available to conduct the survey.

4 RESULTS

4.1 Desktop Assessment

4.1.1 Database Searches

Database results utilised included the DPaW Threatened and Priority flora database (DPaW 2014a), NatureMap database (DPaW 2014c) and an EPBC Act Protected Matters Search (DoE 2014).

The review of the database searches identified a total of 27 species of Threatened and Priority Flora previously recorded within 50 km of the survey area (DPaW 2014a; DPaW 2014c; and DoE 2014). This comprised one Threatened species, 11 Priority 1 taxa, two Priority 2 species, 11 Priority 3 taxa and two Priority 4 taxa (Table 4).

Table 4: Threatened and Priority Flora within 50 km of the Survey Area

Species	Conservation Status		DPaW 2014a	DPaW 2014c	DoE 2014
	WC Act (State)	EPBC Act (Federal)			
Lepidium catapycnon	T	Vulnerable	✓	✓	✓
Acacia aphanoclada	P1		✓	✓	
Acacia cyperophylla var. *omearana*	P1		✓	✓	
Acacia sp. Marble Bar (J.G. & M.H. Simmons 3499)	P1		✓		
Acacia sp. Nullagine (B.R. Maslin 4955)	P1		✓	✓	
Atriplex spinulosa	P1		✓	✓	
Cochlospermum macnamarae	P1		✓	✓	
Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) PN	P1		✓		
Fimbristylis sp. Shay Gap (K.R. Newbey 10293)	P1		✓	✓	
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	P1		✓		
Tribulus minutus	P1		✓		
Stemodia sp. Battle Hill (A.L. Payne 1006)	P1			✓	
Indigofera ixocarpa	P2		✓	✓	
Vigna sp. central (M.E. Trudgen 1626)	P2			✓	
Acacia fecunda	P3		✓	✓	
Acacia levata	P3		✓	✓	
Eragrostis crateriformis	P3		✓	✓	
Eucalyptus rowleyi	P3		✓	✓	
Gomphrena leptophylla	P3		✓		
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3		✓		
Heliotropium murinum	P3		✓		
Nicotiana umbratica	P3		✓	✓	
Rostellularia adscendens var. *latifolia*	P3		✓	✓	
Swainsona thompsoniana	P3			✓	
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3		✓	✓	
Goodenia nuda	P4		✓	✓	
Ptilotus mollis	P4		✓	✓	

4.1.2 Previous Flora and Vegetation Assessments

In recent decades, a boom in large-scale mining projects in the Pilbara has resulted in numerous site-specific biological survey reports. Two publicly available flora and vegetation assessment reports compiled following surveys previously conducted in the vicinity of the Beatons Creek survey area were reviewed during the desktop assessment:

- Nullagine Iron Ore Joint Venture Project Expansion Level 2 Flora and Vegetation Survey (Plant Ecology Consulting 2013); and

- Flora and Vegetation of the Nullagine Project Areas (Mattiske Consulting 2010).

The key findings of each report are presented in Table 5. It should be noted that differences in survey timing, extent and the size and locations of each project area will influence the results of each survey. For further details of specific survey methods and timing please refer to the original report. Different vegetation definition protocols were used in these surveys than have been used for the Beatons Creek assessment. However, vegetation similarities are discussed in Section 5.5.

Table 5: Summary of Key Results from Previous Flora and Vegetation Surveys Conducted in the Vicinity of the Survey Area

Assessment	Consultant	Client	Location	Survey Area	Survey Time	Survey Effort	Number of Taxa Recorded	*Introduced Flora*	TECs	PECs	Threatened / Priority Flora
Nullagine Iron Ore Joint Venture Project Expansion Level 2 Flora and Vegetation Survey	Plant Ecology Consulting 2013	BC Iron	30 km south west of Nullagine	1,972 ha	24/04/2013 - 02/05/2013	58 relevés	294 taxa	**Calotropis procera*	Nil	Nil	Nil
					14/09/2013 - 21/09/2014	49 map points	52 families	**Cenchrus ciliaris*			
							138 genera	**Argemone ochroleuca* subsp. *ochroleuca* **Cenchrus setiger* **Cynodon dactylon* **Setaria verticillata* **Vachellia farnesiana* **Malvastrum americanum* **Aerva javanica* **Portulaca oleracea* **Citrullus colocynthis* **Cucumis melo* subsp. *agrestis* **Flaveria trinervia* **Bidens bipinnata*			
Flora and Vegetation of the Nullagine Project Areas	Mattiske Consulting 2010	Millennium Minerals Limited	8 km south of Nullagine	Not indicated	Jul-05	213 sites	259 taxa	**Argemone ochroleuca* subsp. *ochroleuca*	Nil	Mosquito Land System	*Lepidium catapycnon*
					Apr-06		39 families	**Cenchrus ciliaris*			*Acacia aphanoclada*
					May-10		102 genera	**Cenchrus setiger* **Gomphrena celosioides* **Pennisetum pedicellatum* **Vachellia farnesiana*			*Ptilotus mollis*

4.2 Flora Overview

A total of 173 taxa (including species, subspecies, varieties and forms) from 91 genera and 43 families were recorded in the survey area. An average of 15.3 species were recorded in each quadrat (from 41 quadrats). The commonly occurring families were; Fabaceae (41 taxa), Poaceae (14 taxa), and Malvaceae (13 taxa). Of the 43 families, 20 were represented by a single species. The most frequently recorded genera were *Acacia* (28 taxa), *Ptilotus* (seven taxa) and *Senna*, *Sida* and *Goodenia* (five taxa each).

Of the 91 genera recorded, 60 were represented by a single species. Of the 173 taxa recorded, three were only able to be identified to genus level (*Amaranthus* sp., *Acacia* sp. and *Solanum* sp.) and one species was only able to have a tentative genus name applied (?*Sauropus* sp.). These incomplete identifications were due to a lack of identifying features including flowers and/or fruiting bodies. In addition, two *Acacia* species (*Acacia trachycarpa* x ?*monticola* and *Acacia trachycarpa* x ?*tumida*) were unable to be fully identified as they represented hybrids and did not have flowers or fruiting bodies.

Quadrat and relevé data, including site photographs, is presented in Appendix F, the flora inventory is presented in Appendix G and a matrix indicating the species recorded in each quadrat and relevé is presented in Appendix H.

4.3 Flora of Conservation Significance

No Threatened species listed under the EPBC Act and/or gazetted as Threatened under the WC Act were recorded during the survey. Three Priority species, as recognised by the DPaW, were recorded during the survey: *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1). Details of locations of these species are presented in Appendix I and Figure 7.

Acacia aphanoclada (Priority 1)

Acacia aphanoclada (Plate 1) is a slender, wispy shrub with a single main stem and growing to a height of 1.5 – 7 m (WAH 2014). Racemes of flowers occur from August to October and the phyllodes are distinctly long and narrow (20-45 mm x 1.5-3 mm) (DEC 2013). A total of 1,686 individuals of *Acacia aphanoclada* were recorded during the survey. (Appendix I; Figure 7). *Acacia aphanoclada* primarily occurred within vegetation association ElAaAoAhTbTe in the north-eastern portion of the survey area with scattered individuals recorded in the southern half of the survey area (Figure 8).


Plate 1: *Acacia aphanoclada* (Priority 1)

Acacia cyperophylla var. *omearana* (Priority 1)

Acacia cyperophylla var. *omearana* (Plate 2) is a tree with distinct red-brown "minnie-ritchie" bark and occurring in drainage lines. It grows from 4 – 10 m and flowers from March to April (WAH 2014). A total of three individuals of this species were recorded in vegetation association ElAoAsAhTbTe (Appendix I; Figure 7).


Plate 2: *Acacia cyperophylla* var. *omearana* (Priority 1)

Ptilotus wilsonii (Priority 1)

Ptilotus wilsonii (Plate 3) is a low shrub growing to 0.5 m on gravelly hillslopes with dense branchlets and grey foliage (WAH 2014). Two individuals of this species were recorded during the survey (Appendix I; Figure 7). One individual occurred within the vegetation association ElAoAsAhTbTe and the other individual occurred within ElAbTeTb.

Plate 3: *Ptilotus wilsonii* (Priority 1)

The list of Threatened and Priority Flora previously recorded in the vicinity of the survey area (as indicated in the database searches in Table 4) was reconsidered following the survey. The purpose is to assess the likelihood of each species occurring within the survey area, following the survey. The likelihood assessment considered the known preferred habitat of each species, the suitability of habitat within the survey area (based on habitats viewed throughout the survey area during the field survey), the life form of each species (annual or perennial) and the proximity of previous records to the survey area (Table 6).

All factors were considered in the likelihood assessment for each species (i.e. likelihood was not based solely on the distance of previous records from the survey area or any other single factor). It is recognised this assessment is subjective, to a degree. However, the intent is to present an indication of the potential of the flora presented in the database searches occurring in the survey area, based on the information available and the field survey results.

Table 6: Likelihood of Threatened and Priority Flora Occurring in the Survey Area

Species	Conservation Status	Habitat (WAH 2014)	Annual / Perennial	Observable During Survey Period	Closest Record to the Survey Area (DPaW 2014a)	Likelihood of Occurring in the Survey Area
Lepidium catapycnon	T	Skeletal soils. Hillsides. High in the landscape, shale stone hills.	Perennial herb or shrub	Yes	17.3 km	Unlikely
Acacia aphanoclada	P1	Skeletal stony soils. Rocky hills, ridges and rises.	Perennial shrub	Yes	Within survey area	Recorded
Acacia cyperophylla var. *omearana*	P1	Stony and gritty alluvium. Along drainage lines.	Tree	Yes	Within survey area	Recorded
Acacia sp. Marble Bar (J.G. & M.H. Simmons 3499)	P1	Watercourse among low rocky hills in unconsolidated sand.	Perennial shrub	Yes	^ 70 km	Unlikely
Acacia sp. Nullagine (B.R. Maslin 4955)	P1	Rocky clay. Low-lying areas between rocky hills.	Perennial shrub	Yes	25 km	Possible
Atriplex spinulosa	P1	Creek banks, clay flats, foot slopes of low hills.	Annual herb	Possible / No	0.4 km	Likely
Cochlospermum macnamarae	P1	Around granite boulders, hills.	Perennial shrub	Yes	27 km	Unlikely
Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) PN	P1	Gully at base of hills, gully on a mesa	Perennial shrub	Yes	^ 140 km	Unlikely
Fimbristylis sp. Shay Gap (K.R. Newbey 10293)	P1	Sandy soil. Drainage line. Edge of pool.	Annual sedge	Possible / No	27.5 km	Possible
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	P1	Mid slope of very steep ironstone hill slope, Base of very steep sandstone hillslope	Perennial shrub	Yes	^ 125 km	Unlikely
Stemodia sp. Battle Hill (A.L. Payne 1006)	P1	Cracking clay, floodplain, crabhole plain,	Perennial shrub	Yes	^ 34 km	Unlikely
Tribulus minutus	P1	Stony rise; growing on old track clear of Triodia. Calcrete/silcrete limestone; red sand.	Perennial herb	Yes	^ 117 km	Unlikely
Indigofera ixocarpa	P2	Skeletal red soils over massive ironstone.	Perennial shrub	Yes	0.08 km	Likely
Vigna sp. central (M.E. Trudgen 1626)	P2	Flat valley floor, cracking clay plain, sand plain, alluvial creek bank.	Annual or perennial vine	Possible	^ 27 km	Unlikely
Acacia fecunda	P3	Quartzite gibbers over skeletal soil. Shallow creeks and drainage lines, hills, road verges.	Perennial shrub	Yes	11.5 km	Possible

Species	Conservation Status	Habitat (WAH 2014)	Annual / Perennial	Observable During Survey Period	Closest Record to the Survey Area (DPaW 2014a)	Likelihood of Occurring in the Survey Area
Acacia levata	P3	Sand or sandy loam over granite. Hillslopes. Granite outcrop. Stony clay-loam on flats in low hilly country.	Perennial shrub	Yes	34.8 km	Unlikely
Eragrostis crateriformis	P3	Clayey loam or clay. Creek banks, depressions.	Annual grass	Possible / No	25.5 km	Possible
Eucalyptus rowleyi	P3	Creek banks, Steep rocky slope, high in landscape, edge of clay pan, plains,	Tree	Yes	11.7 km	Possible
Gomphrena leptophylla	P3	Sand, sandy to clayey loam, granite, quartzite. Open flats, sandy creek beds, edges salt pans & marshes, stony hillsides.	Annual herb	Possible / No	^ 85 km	Unlikely
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.	Annual or biennial herb	Possible / No	^ 70 km	Possible
Heliotropium murinum	P3	Red sand. Sand plains, stony plains, road side edge	Short-lived perennial	Possible / No	38.9 km	Possible
Nicotiana umbratica	P3	Shallow soils. Rocky outcrops. Rocky gorges.	Short-lived annual or perennial herb	Possible / No	27.9 km	Possible
Rostellularia adscendens var. *latifolia*	P3	Ironstone soils. Near creeks, rocky hills. Gully dissecting calcrete plains. Flood plain. Moderate to steep gorge.	Perennial shrub	Yes	25.7 km	Possible
Swainsona thompsoniana	P3	Cracking clay floodplain, creekline, clay plain	Annual herb	Possible / No	^ 34 km	Unlikely
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	Red clay. Clay pan, grass plain. Drainage line. Seasonally inundated flats.	Perennial tussock grass	Yes	22.7 km	Possible
Goodenia nuda	P4	Sand plain, flood plain, valley, drainage line, Ironstone and granite hills	Perennial herb	Possible / No	24.9 km	Possible
Ptilotus mollis	P4	Stony hills and screes. Steep ironstone hillslope. Red clay loam. Broad steep sided gully. Scree slope.	Perennial shrub	Yes	7.7 km	Possible

^ No point location provided with DPaW database search (DPaW 2014a); therefore, point location determined from nearest Florabase vouchered record (WAH 2014)

4.4 Introduced Flora

Three introduced species were recorded from the survey area:

- **Aerva javanica* (Kapok Bush; Plate 4);
- **Calotropis procera* (Calotrope / Rubber Tree; Plate 5); and
- **Cenchrus ciliaris* (Buffel Grass; Plate 6).

None of these species are registered as WONS. One of the three species is listed as a Declared Plant (C3 management category) under the BAM Act (WA): **Calotropis procera*. The ranking of each of the three species in the DPaW Weed Prioritisation Process (DPaW 2013), is presented in Table 7.

None of the weed species were commonly occurring within the survey area with only scattered individuals recorded throughout. The area around the dam had the highest density of weeds, however the coverage of weeds in this location was still below 1%. Approximately 20 individuals of **Calotropis procera* occur in the waste tailings piles from the historical exploration and prospecting activities within the survey area on the south side of the dam.

Table 7: Introduced Flora Recorded in the Survey Area, Including their Ranking by the DPaW Weed Prioritisation Process (DPaW 2013)

Species	Ranking	Comment
**Aerva javanica* (Kapok Bush)	Low	Protect priority sites (aims to prevent spread of weed species to key sites/assets of high biodiversity, social, cultural or economic value)
**Calotropis procera* (Calotrope / Rubber Tree)	Alert	Declared weed known from Pilbara region (De Grey, Karratha townsite) but not on DPaW estate. Milky sap causes dermatitis, herbicide trials being conducted
**Cenchrus ciliaris* (Buffel Grass)	Low	Protect priority sites (aims to prevent spread of weed species to key sites/assets of high biodiversity, social, cultural or economic value)

Plate 4: **Aerva javanica* (Kapok Bush)

Plate 5: **Calotropis procera* (Calotrope / Rubber Tree)

Plate 6: **Cenchrus ciliaris* (Buffel Grass)

4.5 VEGETATION ASSOCIATIONS

A total of 11 vegetation associations were identified across the survey area (Figure 9). The extent of each association is presented in Table 8. The most widespread vegetation association was ElAoAsAhTbTe comprising 79.18% and 920.07 ha within the survey area. This vegetation association occurred across the hills and slopes throughout survey area.

The statistical analysis dendrogram from the quadrat results is presented in Appendix J. Further details including the specific quadrat and relevé sites within each association, associated species a representative photo are presented in the following pages. Although there are no quadrats or relevés listed within vegetation associations AsyAbTlTe and EcTsp, these associations were assessed, defined and mapped in the field.

Table 8: Vegetation Associations Summary and Area Extents

Landform	Vegetation Code	Vegetation Association	Extent in Survey Area (ha)	Extent in Survey Area (%)
Drainage	EcTsp	Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over sedgeland of *Typha domingensis*	2.36	0.2
	ElAtGwAmTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland open shrubland of *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* subsp. *hispidula* and *Acacia monticola* over open hummock grassland of *Triodia epactia*	22.57	1.94
	ElChAtGwImAsTe	Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over closed scrub of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Indigofera monophylla* over scattered low shrubs of *Acacia spondylophylla* over open hummock grassland of *Triodia epactia*	0.82	0.07
	ElEvAtTeCi	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Eucalyptus victrix* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* over scattered sedges of *Cyperus ixiocarpus*	7.19	0.62
	ElMgAtTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Melaleuca glomerata* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*	9.27	0.80
	ElMgTeGlCa	Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high open shrubland of *Melaleuca glomerata* over very open herbland of *Goodenia lamprosperma* and *Chrysocephalum apiculatum*	11.64	1.00

Landform	Vegetation Code	Vegetation Association	Extent in Survey Area (ha)	Extent in Survey Area (%)
Flood Plain	ElChAtGwImWvTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over high open shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Indigofera monophylla* and *Waltheria virgata* over open hummock grassland of *Triodia epactia*	3.22	0.28
Stony Plain	AsyAbTlTe	Scattered shrubs of *Acacia synchronicia* (broad leaf form) and *Acacia bivenosa* over open hummock grassland of *Triodia longiceps* and *Triodia epactia*	25.93	2.23
Hills	ElAaAoAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered tall shrubs of *Acacia aphanoclada* over scattered low shrubs of *Acacia orthocarpa* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*	24.33	2.09
	ElAbTeTb	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered shrubs of *Acacia bivenosa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*	39.67	3.41
	ElAoAsAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia orthocarpa*, *Acacia spondylophylla* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*	920.07	79.18
Disturbed			94.92	8.17
Total			**1162**	**100**

Vegetation Associations in the Survey Area

Landform: Drainage

Vegetation Association: EcTsp

Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over sedgeland of *Typha domingensis*

Extent of Association within Survey Area: 2.36 ha (0.2%)

Quadrats and Relevés within Association: -

Associated Species:

Overstorey	Mid-storey	Understorey
-	*Acacia* sp.	*Triodia* sp.

Landform: Drainage

Vegetation Association: ElAtGwAmTe

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland open shrubland of *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* subsp. *hispidula* and *Acacia monticola* over open hummock grassland of *Triodia epactia*

Extent of Association within Survey Area: 22.57 ha (1.94%)

Quadrats and Relevés within Association: BC01, BC06, BC11, BC13, BC16, BC20, BC44, BC47, BC48, BC50, BC56 BCR17, BCR24, BCR34, BCR35

Associated Species:

Overstorey	Mid-storey	Understorey
Acacia adsurgens	*Acacia pyrifolia* var. *pyrifolia*	*Acacia orthocarpa*
Corymbia deserticola subsp. *deserticola*	*Acacia retivenea* subsp. *clandestina*	*Corchorus parviflorus*
Corymbia hamersleyana	*Senna glutinosa* subsp. *glutinosa*	*Cyperus hesperius*
Ficus brachypoda	*Petalostylis labicheoides*	*Dampiera candicans*
		Eriachne mucronata
		Pluchea dentex

Landform: Drainage

Vegetation Association: ElChAtGwImAsTe

Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over closed scrub of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Indigofera monophylla* over scattered low shrubs of *Acacia spondylophylla* over open hummock grassland of *Triodia epactia*

Extent of Association within Survey Area: 0.82 ha (0.07%)

Quadrats and Relevés within Association: BC59

Associated Species:

Overstorey	Mid-storey	Understorey
Santalum lanceolatum	*Acacia monticola*	*Acacia adoxa* var. *adoxa*
	Acacia pyrifolia var. *pyrifolia*	*Eriachne mucronata*
	Sida arenicola	*Goodenia triodiophila*
		Petalostylis cassioides
		Stemodia viscosa

Landform: Drainage

Vegetation Association: ElEvAtTeCi

Scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Eucalyptus victrix* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* over scattered sedges of *Cyperus ixiocarpus*

Extent of Association within Survey Area: 7.19 ha (0.62%)

Quadrats and Relevés within Association: BC05, BC57

Associated Species:

Overstorey	Mid-storey	Understorey
Ficus brachypoda	*Acacia monticola*	*Cymbopogon ambiguus*
	Acacia orthocarpa	*Cyperus ixiocarpus*
	Indigofera monophylla	*Eriachne mucronata*
	Melaleuca glomerata	*Euphorbia australis* subsp. *subtomentosa*
		Pluchea dentex
		Ptilotus fusiformis

Landform: Drainage

Vegetation Association: ElMgAtTe

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Melaleuca glomerata* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*

Extent of Association within Survey Area: 9.27 ha (0.8%)

Quadrats and Relevés within Association: BC08, BC12

Associated Species:

Overstorey	Mid-storey	Understorey
Corymbia candida subsp. *dipsodes*	*Grevillea wickhamii* subsp. *hispidula*	*Acacia maitlandii*
	Senna glutinosa subsp. *glutinosa*	*Cassytha capillaris*
		Eriachne mucronata
		Gonocarpus ephemerus
		Indigofera monophylla
		Phyllanthus maderaspatensis

Landform: Drainage

Vegetation Association: ElMgTeGlCa

Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high open shrubland of *Melaleuca glomerata* over very open herbland of *Goodenia lamprosperma* and *Chrysocephalum apiculatum*

Extent of Association within Survey Area: 11.64 ha (1%)

Quadrats and Relevés within Association: BC52, BC53, BC54

Associated Species:

Overstorey	Mid-storey	Understorey
Melaleuca argentea	*Acacia coriacea* subsp. *pendens*	*Centipeda minima* subsp. *macrocephala*
	Acacia tumida var. *pilbarensis*	*Dysphania plantaginella*
		Heliotropium chrysocarpum
		Schenkia clementii

Landform: Flood plain

Vegetation Association: ElChAtGwImWvTe

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over high open shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Indigofera monophylla* and *Waltheria virgata* over open hummock grassland of *Triodia epactia*

Extent of Association within Survey Area: 3.22 ha (0.28%)

Quadrats and Relevés within Association: BC09, BC15

Associated Species:

Overstorey	Mid-storey	Understorey
-	*Acacia maitlandii*	*Acacia bivenosa*
	Eremophila latrobei subsp. *latrobei*	*Acacia trachycarpa*
	Indigofera monophylla	*Corchorus parviflorus*
	Santalum lanceolatum	*Hibiscus sturtii* var. *campylochlamys*
		Pluchea dentex
		Scaevola browniana subsp. *browniana*
		Waltheria virgata

Landform: Stony plain

Vegetation Association: AsyAbTlTe

Scattered shrubs of *Acacia synchronicia* (broad leaf form) and *Acacia bivenosa* over open hummock grassland of *Triodia longiceps* and *Triodia epactia*

Extent of Association within Survey Area: 25.93 ha (2.23%)

Quadrats and Relevés within Association: -

Associated Species:

Overstorey	Mid-storey	Understorey
Eucalyptus leucophloia subsp. *leucophloia*	*Acacia acradenia*	*Goodenia stobbsiana*
	Melaleuca eleuterostachya	*Solanum lanceolatum*

Landform: Hills

Vegetation Association: ElAaAoAhTbTe

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered tall shrubs of *Acacia aphanoclada* over scattered low shrubs of *Acacia orthocarpa* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*

Extent of Association within Survey Area: 24.33 ha (2.09%)

Quadrats and Relevés within Association: BC07, BC14

Associated Species:

Overstorey	Mid-storey	Understorey
-	*Acacia bivenosa*	*Acacia adoxa* var. *adoxa*
	Senna glaucifolia	*Acacia spondylophylla*
		Bulbostylis barbata
		Goodenia stobbsiana
		Ptilotus calostachyus

Landform: Hills

Vegetation Association: ElAbTeTb

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered shrubs of *Acacia bivenosa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*

Extent of Association within Survey Area: 39.67 ha (3.41%)

Quadrats and Relevés within Association: BC33, BC40

Associated Species:

Overstorey	Mid-storey	Understorey
-	*Acacia acradenia*	*Acacia hilliana*
	Hakea chordophylla	*Capparis umbonata*
	Senna glaucifolia	*Haloragis gossei* var. *gossei*
		Ptilotus calostachyus

Landform: Hills

Vegetation Association: ElAoAsAhTbTe

Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia orthocarpa*, *Acacia spondylophylla* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*

Extent of Association within Survey Area: 920.07 ha (79.18%)

Quadrats and Relevés within Association: BC02, BC03, BC04, BC23, BC26, BC36, BC38, BC39, BC42, BC46, BC49, BC55, BC58, BC61, BC62

BCR19, BCR22, BCR27, BCR25, BCR60

Associated Species:

Overstorey	Mid-storey	Understorey
Corymbia deserticola subsp. *deserticola*	*Acacia pyrifolia* var. *pyrifolia*	*Dodonaea coriacea*
Corymbia hamersleyana	*Acacia monticola*	*Gompholobium oreophilum*
	Grevillea wickhamii subsp. *hispidula*	*Goodenia cussackiana*
	Hakea lorea subsp. *lorea*	*Goodenia stobbsiana*
	Senna glaucifolia	*Mollugo molluginea*

4.6 Vegetation Condition

Vegetation condition across the survey area ranged from Excellent to Completely Degraded with the majority of the survey area in Excellent condition (Table 9; Appendix E; Figure 10). The area considered to be in Excellent condition was primarily represented by the outer hills through the north and the west of the survey area where historical exploration and prospecting activities had not previously occurred.

Historical exploration and prospecting activities which were not rehabilitated effectively and tracks associated with the current exploration program on site are the primary disturbances. The area around the dam, particularly where an unsealed road passes over the dam wall, is scattered with litter. Vehicle tracks were evident in some of the creek beds where prospectors had used them as an access route between the hills. Weed species were recorded in relatively scattered densities and were primarily recorded around the dam and through the historical tailings mounds just south of the dam. Scattered individuals of the Declared weed **Calotropis procera* were recorded in the waste tailings from historical activities south of the dam.

Historical exploration and prospecting activities included heavy scraping down the hill slopes for the purpose of pushing topsoil material into the creek in the valley between the steep hills where the material was then able to be processed to extract the gold. These scrapings were not rehabilitated and have not self-rehabilitated since, particularly on the steep slopes. The creek lines throughout the centre of the survey area have also been previously disturbed with historical exploration and prospecting activities having targeted the creeks for gold.

The areas where historical exploration and prospecting activities were conducted now exhibit erosion from rainfall which flows south from the hills in the centre of the survey area taking the topsoil down through the southern corner of the survey area towards the Nullagine River and the Nullagine town site. Fire age was variable across the site and ranged between Young (fire 1-4 years previous) to Very Old (unburnt for 12+ years), with the majority of the survey area considered to have a Moderate (fire 4-8 years previous) fire age.

Table 9: Vegetation Condition and the Extent in the Survey Area

Vegetation Condition (Trudgen 1991)	Extent in Survey Area	
	Hectares	%
Excellent	589.20	50.7
Very Good	387.33	33.3
Good	78.53	6.8
Poor	7.12	0.6
Very Poor	8.02	0.7
Completely Degraded	91.80	7.9
Total	**1162**	**100**

4.7 VEGETATION OF CONSERVATION SIGNIFICANCE

None of the 11 vegetation associations described for the survey area were analogous to any known TECs, PECs or ESAs. No records of TECs occur within a 50 km radius of the survey area. However, the buffer zone for the Mosquito Land System PEC (Priority 3) extends into the survey area (Figure 5). This PEC is primarily situated east of the survey area and covers an area approximately 60 x 30 km in area with only the western border of the PEC extending into the part of the survey area.

There are no known ESAs recorded within the survey area or within 50 km of the survey area. The nearest ESA is the Fortescue Marsh, approximately 80 km south of the survey area. The survey area is situated within a recognised Schedule 1 Area (as recognised under the *Environmental Protection [Clearing of Native Vegetation] Regulations 2004*) (DER 2014). The Schedule 1 area encompasses the Nullagine Water Reserve (Water and Rivers Commission 1999).

5 DISCUSSION

5.1 FLORA

The survey recorded 173 taxa, which is comparable to the number of taxa recorded in previous surveys conducted in the vicinity of Nullagine: 294 taxa (Plant Ecology Consulting 2013) and 259 taxa (Mattiske Consulting 2010). These previous surveys cover areas larger than that of the Beatons survey area and comprised a greater complexity of vegetation. Hence, the elevated species number for the previous surveys. It is likely more species would be recorded if a survey as conducted following a significant rainfall event

Average species richness from the survey was 15.3 taxa per quadrat from 41 quadrats. The hill slopes throughout the centre of the survey area presented the lowest diversity with some quadrats having less than 10 species. The soils on these hills are particularly skeletal and the steep slopes likely prevent much rainfall infiltration. The drainage lines and areas around the dam presented a higher species diversity with a higher number of annuals occurring.

The flora of the survey area is generally typical of the eastern Pilbara and the species list was similar to that recorded by Plant Ecology Consulting (2013) and Mattiske Consulting (2010) who assessed larger survey areas in the same vicinity of Nullagine. The survey of the Beatons Creek area returned the same three dominant families (Fabaceae, Poaceae and Malvaceae) and the same three dominant genera (*Acacia, Ptilotus* and *Senna*) as both Plant Ecology Consulting (2013) and Mattiske Consulting (2010).

5.2 FLORA OF CONSERVATION SIGNIFICANCE

Three taxa of conservation significance were recorded during the survey (Figure 7): *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1). No Threatened species listed under the EPBC Act and/or gazetted as Threatened under the WC Act were recorded during the survey.

Lepidium catapycnon (Threatened)

Mattiske Consulting (2010) recorded *Lepidium catapycnon* (Threatened) at three locations during a survey conducted in 2005. These locations were 17 km east of the Beatons Creek survey area. Known records of *Lepidium catapycnon* were also presented in the database search results requested from the DPaW prior to the survey. Therefore, the survey area was thoroughly searched for any occurrences of the Threatened species, particularly in known habitats including the steep hills of the survey area which comprise the target mining area.

The survey timing to identify the species in situ was considered suitable as it is a perennial species and both botanists conducting the survey were well experienced identifying *Lepidium catapycnon* in the field. No individuals were recorded and, as such, it is considered unlikely to occur in the survey area.

Atriplex spinulosa (Priority 1) and *Indigofera ixocarpa* (Priority 2)

Of the remaining 26 Priority flora returned in the combined database searches, as listed in the likelihood table, two were considered to be likely of occurring within the survey area: *Atriplex spinulosa* (Priority 1) and *Indigofera ixocarpa* (Priority 2). Even though these two species were not recorded during the survey, they are still considered likely to occur in the survey area due to previous records existing within 500 m of the survey area boundary and suitable habitat present within the survey area.

Atriplex spinulosa (Priority 1) is an annual herb and, as such, may not have present or evident at the time of the survey which was conducted in September. The species is known from 12 voucher records at the Western Australian Herbarium (WAH 2014). The majority of the 12 records are from the Nullagine area, within the clay flats of the Mosquito Creek land system. Although this land system extends into the survey area, the representation is poor as it is shows significant previous disturbance and the majority of the vegetation in that area was considered to be in Completely Degraded condition (Figure 10). In addition, the vouchered collection of *Atriplex spinulosa* from nearby the survey area was made in 1974 and there is a possibility it may no longer occur in the area.

Indigofera ixocarpa (Priority 2) is considered likely to occur in the survey area as a previous record for the species has been made at the Beatons Creek rock hole, immediately south of the survey area. It is a small perennial, typically thin and spindly shrub occurring on hill slopes (WAH 2014). However, it is likely the habitats present in the survey area, which are thin, skeletal soils with low rainfall and high runoff from the steep hill slopes, may result in individuals of this species to be smaller and more spindly than usual, and therefore making it difficult to recognise. *Indigofera ixocarpa* is known from 16 voucher records at the Western Australian Herbarium and the majority of these records are from the Tom Price area, approximately 250 km away from the survey area (WAH 2014). In addition, the three vouchered collections of *Indigofera ixocarpa* from the Beatons Creek rock hole were made in 1982 and 1984 and there is a possibility it may no longer occur in the area.

Acacia aphanoclada (Priority 1)

A total of 1,686 individuals of *Acacia aphanoclada* were recorded during the survey. It primarily occurred on areas of calcrete-like outcropping throughout the survey area with the main population occurring in the north east of the survey area (Appendix I; Figure 7). The vegetation association *Acacia aphanoclada* primarily occurred within was ElAaAoAhTbTe in the north-eastern portion of the survey area with scattered individuals recorded in the southern half of the survey area (Figure 8).

It is known to occur on skeletal stony soils on rocky hills and ridges and is known from 36 records vouchered with the Western Australian Herbarium (WAH 2014). These records are all in the immediate Nullagine area, within approximately a 50 km radius of Nullagine.

It is likely the main population of *Acacia aphanoclada* recorded in the north-eastern portion of the survey area represents a significant population for the species in general. However, it is likely further surveys throughout the area could present additional populations and possibly a greater distribution than is currently known, particularly as populations were visible from the Marble Bar Road north and south of Nullagine.

At this stage, it is unlikely the proposed Gold Project will impact the main population as it is outside the current proposed project footprint (although the footprint may change in the future). However, some of the scattered individuals occurring throughout the southern portion of the survey area are likely to be cleared in the project development.

Mattiske Consulting recorded *Acacia aphanoclada* during surveys conducted in 2005, 2006 and 2010 with at least 65 individuals recorded from the combined project areas (Mattiske Consulting 2010). Although, it is likely more than 65 individuals occurred at these locations. However, as no population or number of individuals data was recorded at each GPS point during the 2005 and 2006 surveys, each of the points were only able to be considered as one individual.

Staff from the DPaW convened in 2014 to discuss a Biodiversity Audit to review flora listed on the Pilbara Threatened and Priority lists and the need to accurately reflect the conservation status of these species; particularly given the greater understanding on the population sizes and distribution of many of the species on these lists following numerous biological surveys throughout the Pilbara in recent years. It was recognised numerous species warranted a higher conservation status, while others should receive a downgrade in conservation status and further species still required additional information to assess their conservation status.

Advice from the DPaW in October 2014 indicated it was considered the conservation status of *Acacia aphanoclada* should be reviewed with the view of downgrading the Priority status (*pers. comm*. Stephen van Leeuwen).

Acacia cyperophylla var. *omearana* (Priority 1)

A total of three individuals of this species were recorded on the southern boundary of the survey area on a ridge above the main Beatons Creek channel (Appendix I; Figure 7). These records were within vegetation association ElAoAsAhTbTe, although the drainage channel below the ridge (outside of the survey area) is more representative of the habitat that typically supports *Acacia cyperophylla* var. *omearana*.

It is known from 17 records vouchered with the Western Australian Herbarium (WAH 2014). The majority of the records are from Beatons Pool, approximately 2 km west of Nullagine. Some records are from an area within approximately 40 km of Nullagine and one record approximately 120 km north of Nullagine. There are currently no other known locations of this species. However; it is possible possibility further surveys throughout the East Pilbara area could present further populations and a greater distribution than is currently known.

Records of this species within the survey area were on the southern boundary. The typical habitat of *Acacia cyperophylla* var. *omearana* is the deeper drainage lines such as Beatons creek which is outside the southern boundary of the survey area. It is highly unlikely any individuals of this species will be cleared for the development of the Beatons Creek Gold Project as the recorded individuals are beyond the currently understood resource area. However, there is a possibility indirect impacts could flow on to affect the population of *Acacia cyperophylla* var. *omearana* occurring at the Beatons Rock Hole in Beatons Creek. These indirect impacts could include water drawdown effects from the water bore field proposed for the Gold Project, any contamination of the water table or contaminated surface water flowing into the Beatons Creek.

Advice from the DPaW in October 2014 indicated it was considered the conservation status of *Acacia cyperophylla* var. *omearana* should be reviewed with the view of upgrading the conservation status to Threatened (*pers. comm*. Stephen van Leeuwen). No further progression of this situation has occurred as yet.

Ptilotus wilsonii (Priority 1)

A total of two individuals of this species were recorded on gravelly hill slopes in the survey area near the southern boundary. One individual occurred within the vegetation association ElAoAsAhTbTe and the other individual occurred within ElAbTeTb (Appendix I; Figure 7).

It is currently known from three records vouchered with the Western Australian Herbarium (WAH 2014). One of these three voucher records is a specimen collected from the Beatons Creek survey area which was submitted to the Herbarium immediately following the confirmation of identification. Therefore, prior to the survey, only two records were vouchered with the Western Australian Herbarium. Both of these previous records are from the Little Sandy Desert bioregion. The record of *Ptilotus wilsonii* in the survey area is a range extension of approximately 200 km and the first official record of the species in the Pilbara bioregion. The first record of this species is from the Rudall River National Park, also known as the Karlamilyi National Park. The second record is from approximately 15 km north of the northern boundary of the Rudall River National Park.

There is a possibility further surveys throughout the area could present additional populations and a greater distribution than is currently known. It was recognised in discussions with the DPaW immediately following the taxonomic confirmation of the species, that *Ptilotus wilsonii* is a cryptic species likely to be represented by other populations that have not yet been documented (*pers. comm*. Stephen van Leeuwen).

The conservation status of *Ptilotus wilsonii* was not assessed in 2014 during the Biodiversity Audit of numerous Threatened and Priority listed flora from the Pilbara bioregion.

5.3 Vegetation of Conservation Significance

None of the 11 vegetation associations described for the survey area were considered analogous to any known TECs, PECs or ESAs. No TECs were indicated as occurring within 50 km of the survey area (DPaW 2014b). The buffer zone for the Mosquito Land System PEC (Priority 3) extends into the survey area (Figure 5). This PEC is primarily situated east of the survey area and covers an area approximately 60 x 30 km in size with only the western border of the PEC extending into the part of the Beatons Creek survey area.

The Mosquito Land System comprises 1,840 km^2 within the Pilbara bioregion and the survey area comprises 1.46 km^2 (0.08%) of this extent. In addition, the majority of the portion of the survey area where the PEC buffer zone extends into is considered to be in Completely Degraded condition due to historical exploration and prospecting activities. The area is significantly eroded with little to no ground cover across a large area.

There are no known ESAs currently recorded within 50 km of the survey area; however the survey area is situated within a Schedule 1 area (DER 2014).

The majority of the records of *Acacia aphanoclada* (Priority 1) within the survey area were from a single vegetation association: ElAaAoAhTbTe (Figure 9). As such, this vegetation association may be of conservation significance. The records of *Acacia cyperophylla* var. *omearana* were within vegetation association ElAoAsAhTbTe. However, the drainage channel of Beatons Creek below the ridge (outside of the survey area) where *Acacia cyperophylla* var. *omearana* (Priority 1) was recorded is more representative of the habitat that typically supports this species and as such, vegetation association ElAoAsAhTbTe is not considered to be of conservation significance. *Ptilotus wilsonii* (Priority 1) was recorded in two vegetation associations: ElAoAsAhTbTe and ElAbTeTb. As single records in different vegetation associations it is not considered that either of these two associations are of conservation significance based on the records of *Ptilotus wilsonii*.

Groundwater Dependant Ecosystems (GDEs) can be considered as vegetation of conservation significance as impacts to the groundwater may affect the health of the GDE and the surrounding ecosystems. Groundwater Dependant Ecosystems can be indicated by the presence of specific species including: *Eucalyptus camaldulensis*, *E. victrix*, *Melaleuca argentea*, and *M. glomerata* (*pers. comm*. R. Loomes, DoW). All four of these species were recorded within the survey area in the vegetation associations surrounding the dam and in the creekline vegetation extending upstream from the dam. As such, these vegetation associations (ElMgTeGlCa and ElMgAtTe) may represent GDEs.

The Chichester subregion includes seven Ecosystems at Risk which are subject to a range of threatening processes (Kendrick and McKenzie 2001). One of these seven ecosystems may be present within the survey area: "Saltbush community of the duplex plains - Mosquito Creek series (Nullagine)". One species of Atriplex was recorded within the survey area with scattered individuals occurring across the clayey flats in the southern portion of the survey area. The majority of this area was considered to be in Completely Degraded condition. As such, should this area be considered to represent the "Saltbush community" mentioned above, it is unlikely to be a good representation of the community. The invertebrate and stygofauna ecosystems are not covered in the scope of this assessment.

In addition, the Chichester subregion includes one Wetland of National Significance (De Grey) and two Wetlands of Subregional Significance (Carawine Gorge in the Oakover River and Running Waters and Skull Springs in the Davis River) (Kendrick and McKenzie 2001). None of these three wetlands are relevant the survey area.

5.4 Vegetation Condition and Introduced Flora

Three introduced species were recorded from the survey area, 1.7% of the total taxa recorded. One of the three species is considered as a Declared Plant under the *BAM Act: *Calotropis procera* (Calotrope / Rubber Tree). None of these three species are listed as WONS by the federal government.

The percentage total taxa that were introduced species in the survey area is less than has been recorded from previous surveys in the Nullagine area: 4.8% (14 introduced species from 294 taxa) recorded by Plant Ecology Consulting (2013) and 2.3% (six introduced species from 259 taxa) recorded by Mattiske Consulting (2010).

Introduced species were not abundant in any area of the survey area with only scattered individuals recorded in a few locations. Individuals of **Calotropis procera* were scattered through an area of historical tailings / waste dump material on the south-west side of the dam. **Calotropis procera* is listed as a C3 Management species by the DAFWA and as such, requirements are (DAFWA 2014):

- Introduction of the plant or its seeds into this area is prohibited;
- Supply or advertising supply of this pest into this area is prohibited;
- The infested area must be managed in such a way that alleviates the impact, reduces the number or distribution or prevents or contains the spread of the declared pest in this area; and
- Ensure that any person conducting an activity on the land is aware that measures are required to be taken to control the declared pest.

**Calotropis procera* was also recorded by Plant Ecology Consulting (2013). A total of 125 plants were recorded, representing a significantly larger population than is present within the Beatons Creek survey area.

Vegetation condition throughout the survey area ranged from Excellent to Completely Degraded with the majority of the survey area in Excellent condition. The primary source of disturbance within the survey area is from historical mining activities which were not rehabilitated effectively and tracks associated with the current exploration program, which have been in place for a number of years and were utilised during the historical mining and exploration activities on site. The hillslopes and creek lines throughout the centre and south of the survey area still show obvious signs of historical and current exploration and prospecting.

The outer hills throughout the west, north and north east of the survey area were considered to be in Excellent condition as there did not appear to be any post-European influence. Some of the broader creek lines throughout the survey area appeared to have been used by prospectors as access tracks. In addition, it is likely the majority of the creek lines in the survey area have been previously disturbed by historical mining activities including low to moderate impact gold prospecting. Influence or impact from cattle appeared to be very minimal throughout the survey area.

5.5 Regional Representation

The survey area occurs across one subregion within the Pilbara bioregion: Chichester subregion.

The survey area is characterised by two land systems: Capricorn and Mosquito (van Vreeswyk *et al.* 2004). These land systems are not considered to be restricted in area or distribution as they comprise 5,296 km^2 and 1,840 km^2 of the Pilbara bioregion respectively. The survey area comprises 10.3 km^2 (0.19%) of the total Capricorn land system area and 1.46 km^2 (0.08%) of the total Mosquito land system area.

The vegetation units mapped by Shepherd *et al.* (2001) / Beard (1975) have been assessed to determine the percentage areas considered to be remaining for each unit. The EPA consider vegetation units with low representative areas to be of conservation significance and units with less than 30% area remaining may be considered regionally significant. Two units have been defined within the survey area: 173 / [a2Sr t1,3Hi] and 190 / [a6, 7Sb t3Hi]. Although both units have less than 10% of the total remaining unit area within conservation protected areas, both units are considered to have over 99% area in total remaining in the state, Pilbara region and Chichester subregional zones (Government of Western Australia 2013).

Several of the vegetation associations defined within the survey area were also defined in the surveys conducted by Plant Ecology Consulting (2013) and Mattiske Consulting (2010) in their respective survey areas in the vicinity of Nullagine. Although differing vegetation association description protocols were used between the surveys, all assessments indicated the following species as dominants across many of the vegetation associations: *Corymbia hamersleyana, Eucalyptus camaldulensis, Eucalyptus leucophloia* subsp. *leucophloia, Acacia aphanoclada, Acacia hilliana, Acacia orthocarpa, Acacia tumida, Indigofera monophylla, Grevillea wickhamii, Triodia brizoides, Triodia epactia* and *Triodia longiceps.*

6 RECOMMENDATIONS

MMWC Environmental Pty Ltd makes the following recommendations:

- Any clearing of native vegetation should be conducted using the mitigation hierarchy – avoid, minimise and offset significant residual impacts (if required);
- Clearing of known locations of Priority flora should be avoided or kept to a minimum wherever possible;
- Individuals of the recorded Declared weed species (**Calotropis procera*) should be controlled in order to prevent further spread;
- A weed management plan should be implemented to prevent the further spread of weed species including **Calotropis procera*;
- Ensure soil where **Calotropis procera* is currently growing is not spread or moved to other areas of the site;
- Management measures should be implemented to ensure clearing does not cause appreciable land degradation, including preventing erosion from the cleared areas;
- Should the opportunity arise, additional survey of the flora within the survey area following a significant rainfall event may return further species, particularly annuals;
- Additional surveys of the wider Nullagine area targeting the three Priority 1 flora recorded within the survey area (*Acacia aphanoclada*, *Acacia cyperophylla* var. *omearana* and *Ptilotus wilsonii*) may yield new populations of the species;
- Disturbance of natural drainage channels and large trees within the drainage channels should be avoided or kept to a minimum wherever possible; and
- Implement measures to reduce the risk of fire starting from activities at site, particularly with the proximity of the project to the Nullagine town site.

7 Assessment of Findings Against The Clearing Principles

Any clearing of native vegetation requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under Schedule 6 of the EP Act, or where the clearing is prescribed by regulations in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. Exemptions do not apply in an ESA.

Each of the ten clearing principles, as outlined in the EP Act, have been individually assessed within the scope and knowledge of this flora and vegetation assessment.

Principle A – Native vegetation should not be cleared if it comprises a high level of biological diversity.

The survey identified 173 species of flora from 91 genera and 43 families from a survey area of 1,162 ha. Of these 173 species, three represented conservation significant taxa: *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1).

Acacia aphanoclada (Priority 1) has been recommended by the DPaW for a revision with a view of downgrading its conservation status. In addition, the primary population recorded within the survey area is outside the current impact footprint. Scattered individuals throughout the southern portion of the survey area may be impacted.

Acacia cyperophylla var. *omearana* (Priority 1) has been recommended by the DPaW for a revision with a view of upgrading its conservation status to Threatened. The records of this species within the survey area were on the very southern boundary of the survey area with a larger population outside the survey area. It is unlikely any individuals of this species will be directly impacted within the survey area as they are outside the current impact footprint.

Ptilotus wilsonii (Priority 1) has not previously been recorded within the Pilbara bioregion and represents a range extension of approximately 200 km. It is possible further surveys in the Nullagine area would present further records of this species.

This Clearing Principle should be considered in conjunction with the results from the fauna and habitat assessment of the survey area. However, based on the flora and vegetation survey results, the proposal is unlikely to be at variance with this principle.

Principle B - Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Outside the flora and vegetation assessment scope of works. Refer to the fauna and habitat assessment report for the survey area.

Principle C - Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Three species of Priority flora were recorded within the survey area: *Acacia aphanoclada* (Priority 1), *Acacia cyperophylla* var. *omearana* (Priority 1) and *Ptilotus wilsonii* (Priority 1). No species of Threatened flora were recorded within the survey area. One species of Threatened flora was indicated in the DPaW database searches (50 km radius around the survey area) conducted prior to the survey: *Lepidium catapycnon*. The potential habitat for this species within the survey area was thoroughly searched by two botanists with significant previous experience identifying and recording populations of *Lepidium catapycnon* in the field. No records of *Lepidium catapycnon* were made within the survey area. As such, it was concluded that it is unlikely this Threatened species occurs within the survey area.

Advice from the DPaW in October 2014 indicated it was considered the conservation status of *Acacia cyperophylla* var. *omearana* should be reviewed with the view of upgrading the conservation status to Threatened (*pers. comm*. Stephen van Leeuwen). No further progression of this situation has occurred as yet. Individuals of *Acacia cyperophylla* var. *omearana* recorded within the survey area were on the survey boundary and are unlikely to be impacted.

Therefore, the proposal is unlikely to be at variance with this principle.

Principle D - Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.

No records of a TEC occur within a 50 km radius of the survey area (DPaW 2014b). Two TECs are known to occur in the Pilbara bioregion: *Themeda* grasslands and the Ethel Gorge aquifer stygobiont community. Neither of these communities are considered to occur within the survey area.

Therefore, the proposal is unlikely to be at variance with this principle.

Principle E - Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

The majority of the native vegetation surrounding the survey area remains in a relatively natural state and is predominantly uncleared. The wider Nullagine area comprises the Nullagine town site, station leases with cattle with basic associated infrastructure (cleared light vehicle tracks, tanks, troughs and occasional holding and loading yards). Cleared areas for mining in the vicinity of the survey area are minimal.

Two vegetation units mapped by Shepherd *et al.* (2001) / Beard (1975) have been defined within the survey area: 173 / [a2Sr t1,3Hi] and 190 / [a6, 7Sb t3Hi]. Although both units have less than 10% of the total remaining unit area within conservation protected areas, both units are considered to have over 99% area in total remaining in the state, Pilbara region and Chichester subregional zones (Government of Western Australia 2013).

Therefore, the proposal is unlikely to be at variance with this principle.

Principle F - Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

The survey area contains a man-made dam which was constructed by Nullagine locals in the 1980's. The dam has since become a wetland feature and supports a range of flora and fauna. The creek that flows into the dam runs through the north portion of the survey area and is unnamed. The overflow from the dam flows into the Nullagine River outside of the survey area. Beaton Creek flows outside the survey area, south of the survey area boundary until it meets the Nullagine River near the Nullagine town site.

At this stage, there is no need or requirement to clear any of the vegetation associated with the dam or the main creekline flowing into the dam.

Therefore, the proposal is unlikely to be at variance with this principle.

Principle G - Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

The proposed impacts have the potential to affect soil surfaces resulting in a level of land degradation. The proposed project intends to mine the rock from the hill tops throughout the centre of the survey area. Much of the southern portion and centre of the survey area already shows indications of land degradation due to unmanaged and un-rehabilitated historical exploration and prospecting activities.

The survey area is situated across two land systems: Capricorn and Mosquito. The Capricorn land system has no record of erosion throughout its extent. The Mosquito land system has some records of erosion over 3% of the land system with 1% considered to have slight erosion, 1% considered to have moderate erosion and 1% considered to have severe erosion. The remaining 97% has no record of erosion (van Vreeswyk *et al.* 2004).

There are records of scattered weeds throughout the survey area, predominantly in the historical exploration and prospecting disturbance areas. One weed species recorded was **Calotropis procera* which is a Declared weed in Western Australia. Scattered individuals of this species were emerging from historical tailings / waste material. As a Declared weed, it is a requirement that this species is removed and that further spread is prevented.

The other weed species recorded in the survey area were **Cenchrus ciliaris* and **Aerva javanica*. These species have become more commonly occurring throughout disturbed areas in the Pilbara. Monitoring and management efforts will help prevent these species from becoming more abundant in the survey area.

Therefore, the proposal may be at variance with this principle.

Principle H - Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

The survey area is not located within or adjacent to any conservation reserves. The closest DPaW managed conservation estate is Karijini National Park, which is approximately 146 km south west of the survey area. There are no ESAs within or adjacent to the survey area and there are no TECs recorded within 50 km of the survey area.

However, the entire survey area is situated within a Schedule 1 Area (as recognised under the *Environmental Protection [Clearing of Native Vegetation] Regulations 2004*). The Schedule 1 area encompasses the Nullagine Water Reserve and comprises approximately 19,050 ha with dimensions of approximately 18.5 km x 10.3 km (DER 2014; Water and Rivers Commission 1999).

Therefore, dependent on the Schedule 1 area, the proposal is unlikely to be at variance with this principle.

Principle I - Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

The proposed project area is situated within a public drinking water source area: Nullagine Water Reserve (Water and Rivers Commission 1999). The majority of the project mining area and infrastructure is currently proposed to be situated within the Priority 1 zone with the tailings dam in the Priority 3 zone. However, this may change in the future. It is anticipated strict management protocols will prevent impacts on surface and ground water in the area.

This principle requires results from the hydrology and soil characterisation assessments.

Principle J - Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

All creeks within the survey area carry an annual water flow, only flooding during the summer months with high rainfall. There were small pools in some of the creek lines within the survey area at the time of survey (early September 2014). However, this appeared to be surface water collection remaining from recent rainfall. There do not appear to be any perennial pools within the creek lines, however the dam holds water year round.

Noreena Downs is situated 45 km south of the survey area and has recorded an average annual rainfall of 325 mm from 1911 to 2014 (BoM 2014). Nullagine has an annual evapotranspiration rate of between 300 - 400 mm (BoM 2014). With appropriate drainage control and water management it is unlikely that the proposed clearing will cause or exacerbate the incidence or intensity of flooding.

The principle requires results from the hydrology assessment following the finalisation of the mine plan.

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FIGURES

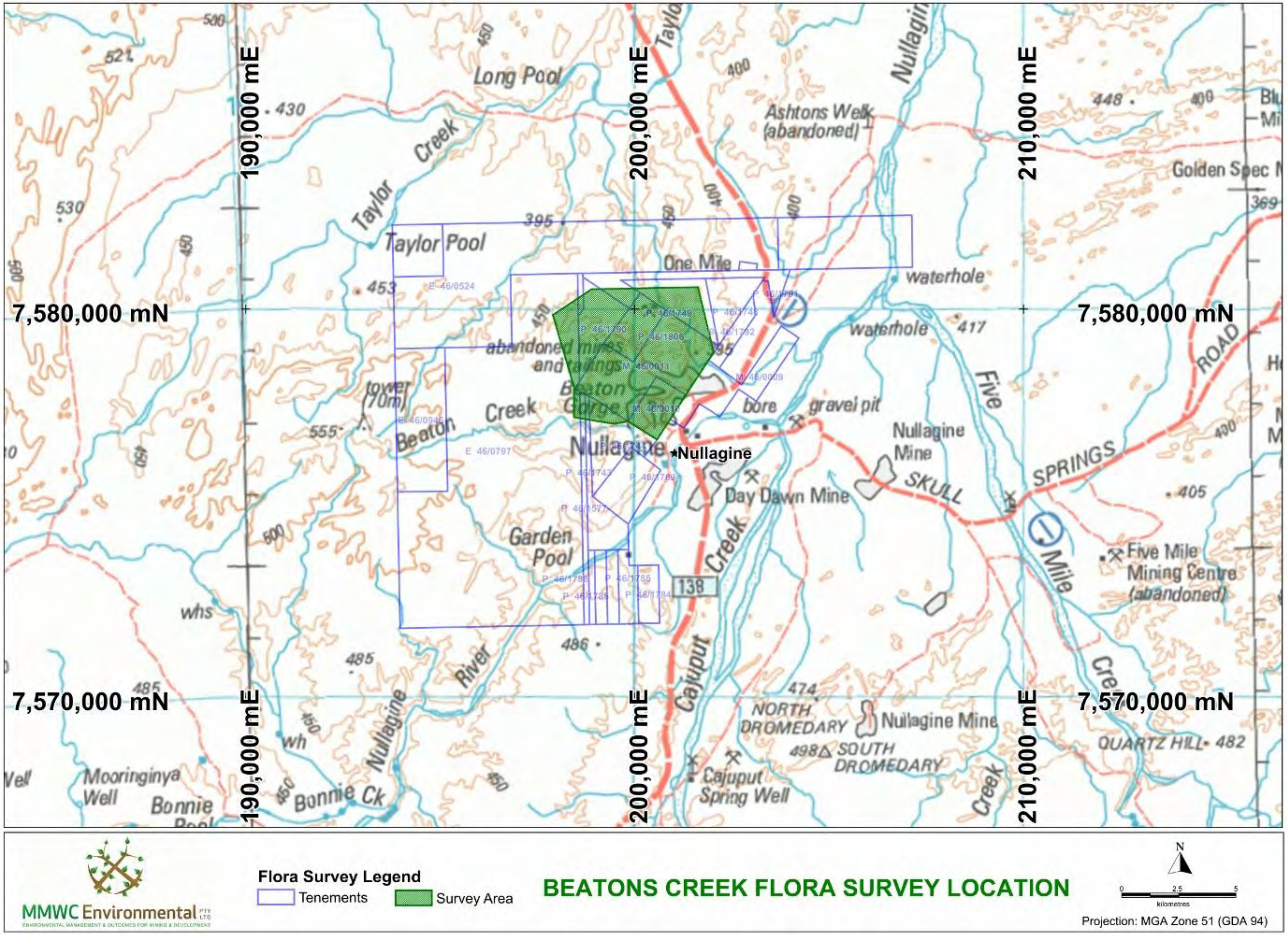

FIGURE 1: Beatons Creek Flora and Vegetation Survey Location

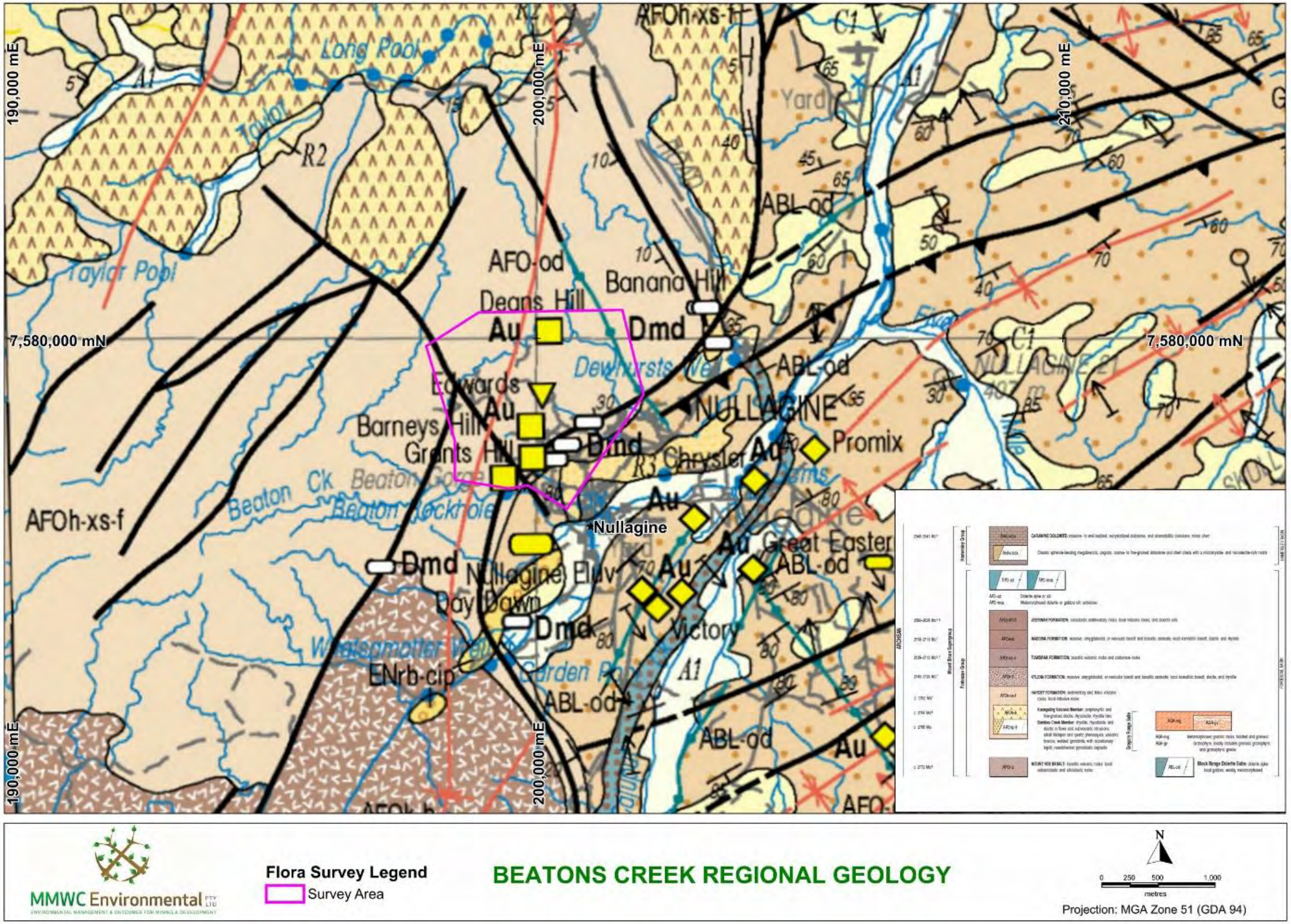

FIGURE 3: Beatons Creek Regional Geology

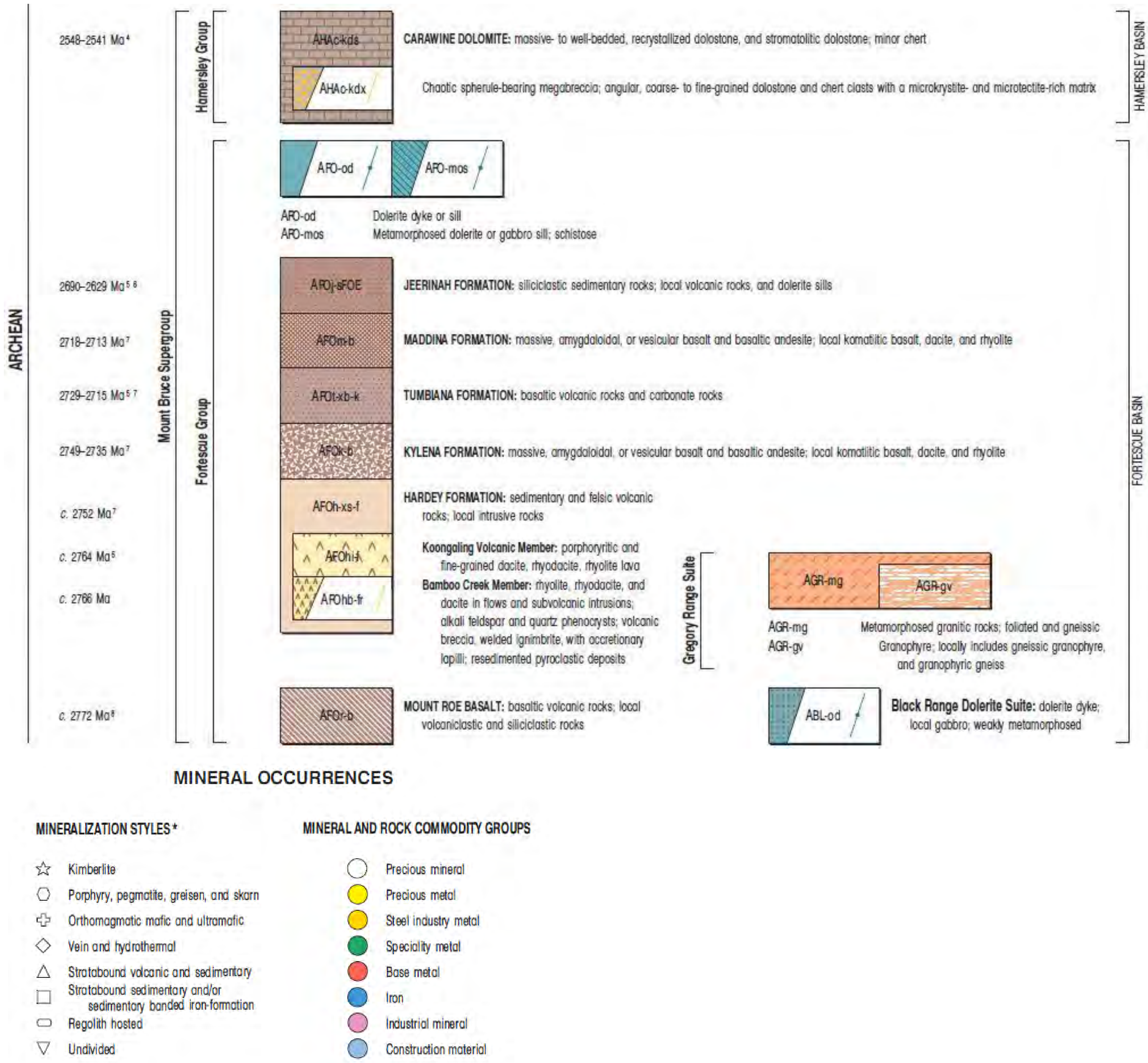

FIGURE 3: Geology Legend

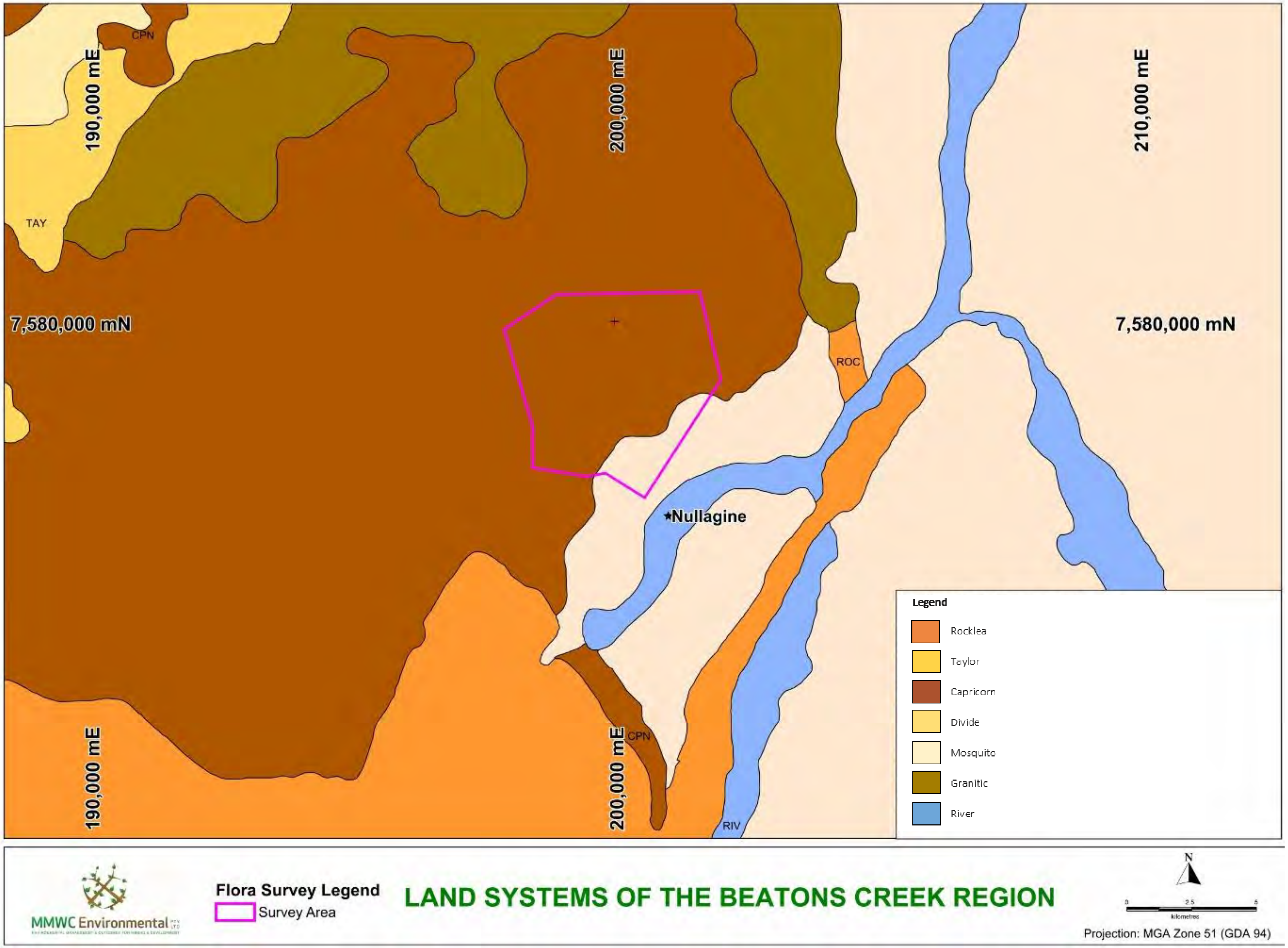

FIGURE 4: Land Systems of the Beatons Creek Region

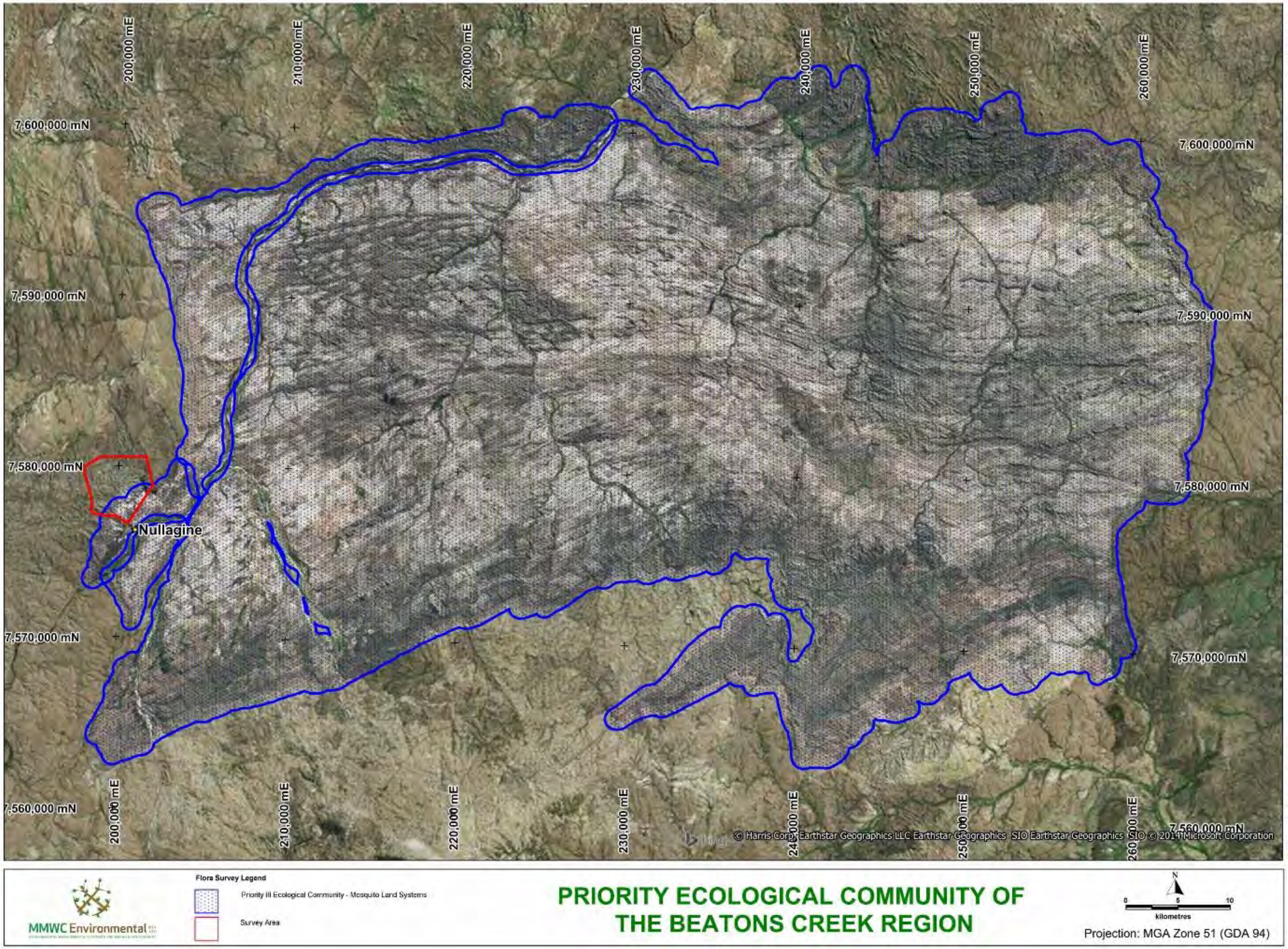

FIGURE 5: Mosquito Land System Priority Ecological Community

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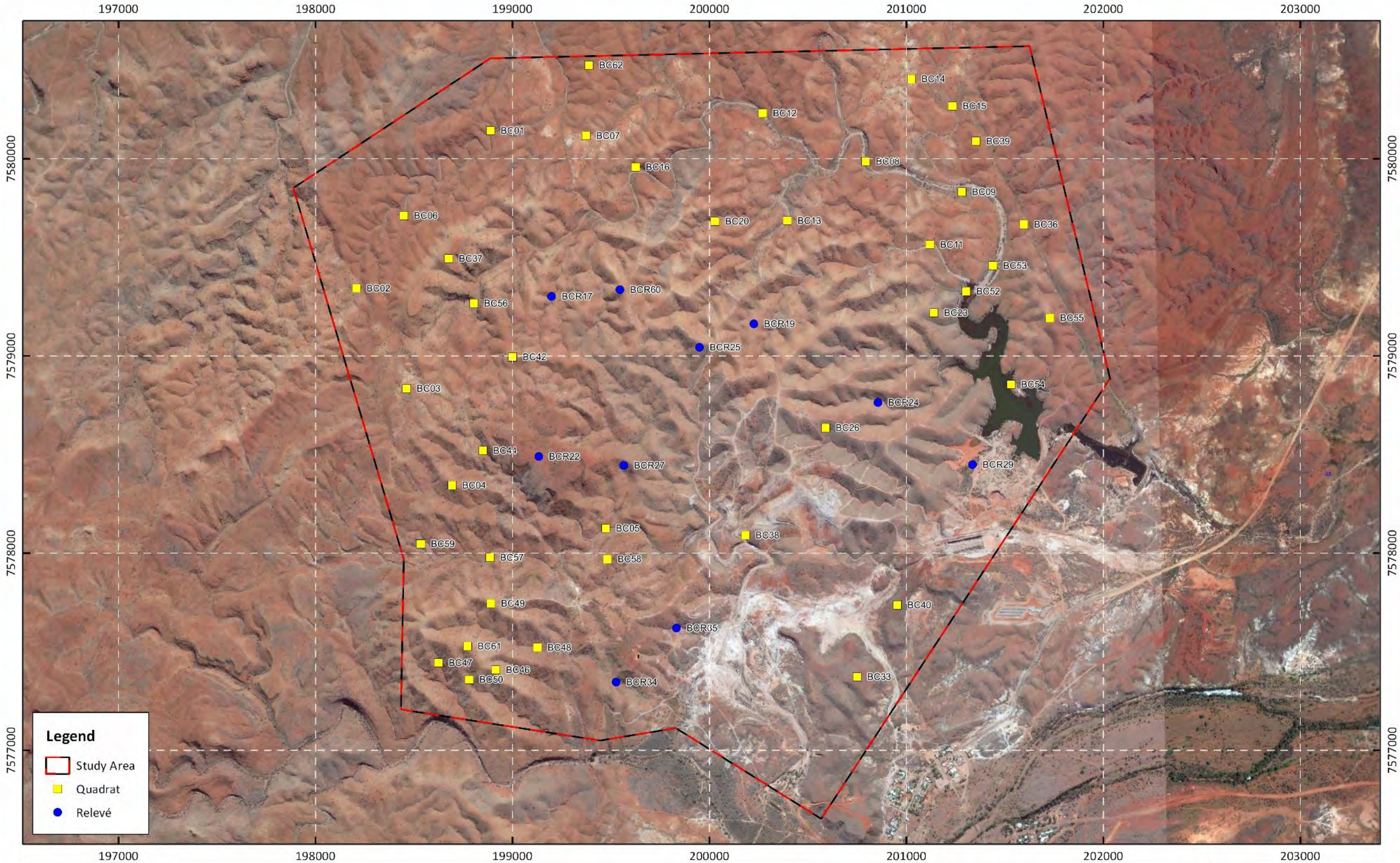

Author: Bridget Watkins	Project Name:	**Figure 6**	0 0.5 1 Kilometres	Figure Num: 6	MMWC Environmental
Drawn: Lewis Trotter		**Locations of Quadrats and Relevés**		Scale: 1 : 17000	
Client: Novo Resources	**Beatons Creek Gold Project**		N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 07/03/2015	
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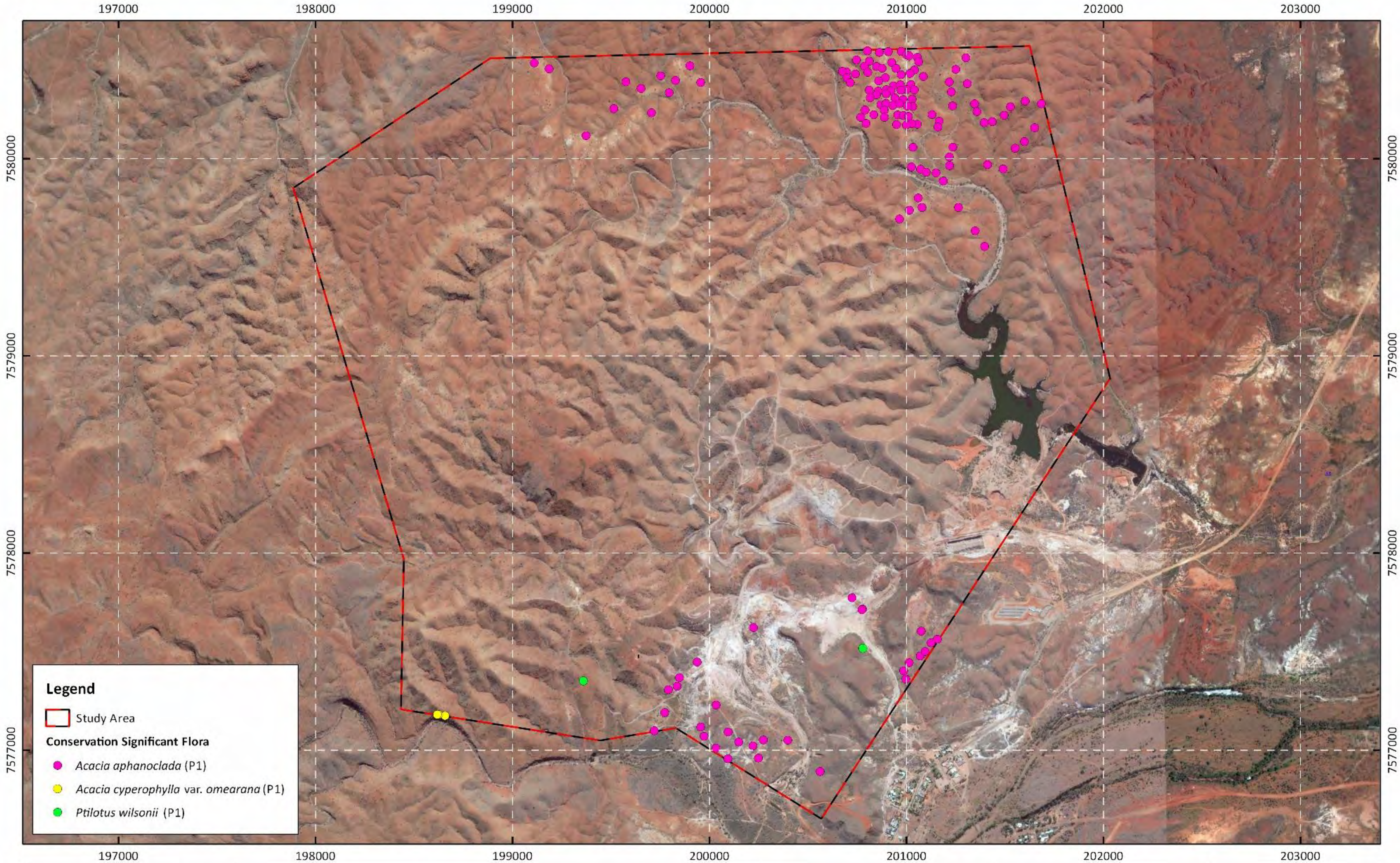
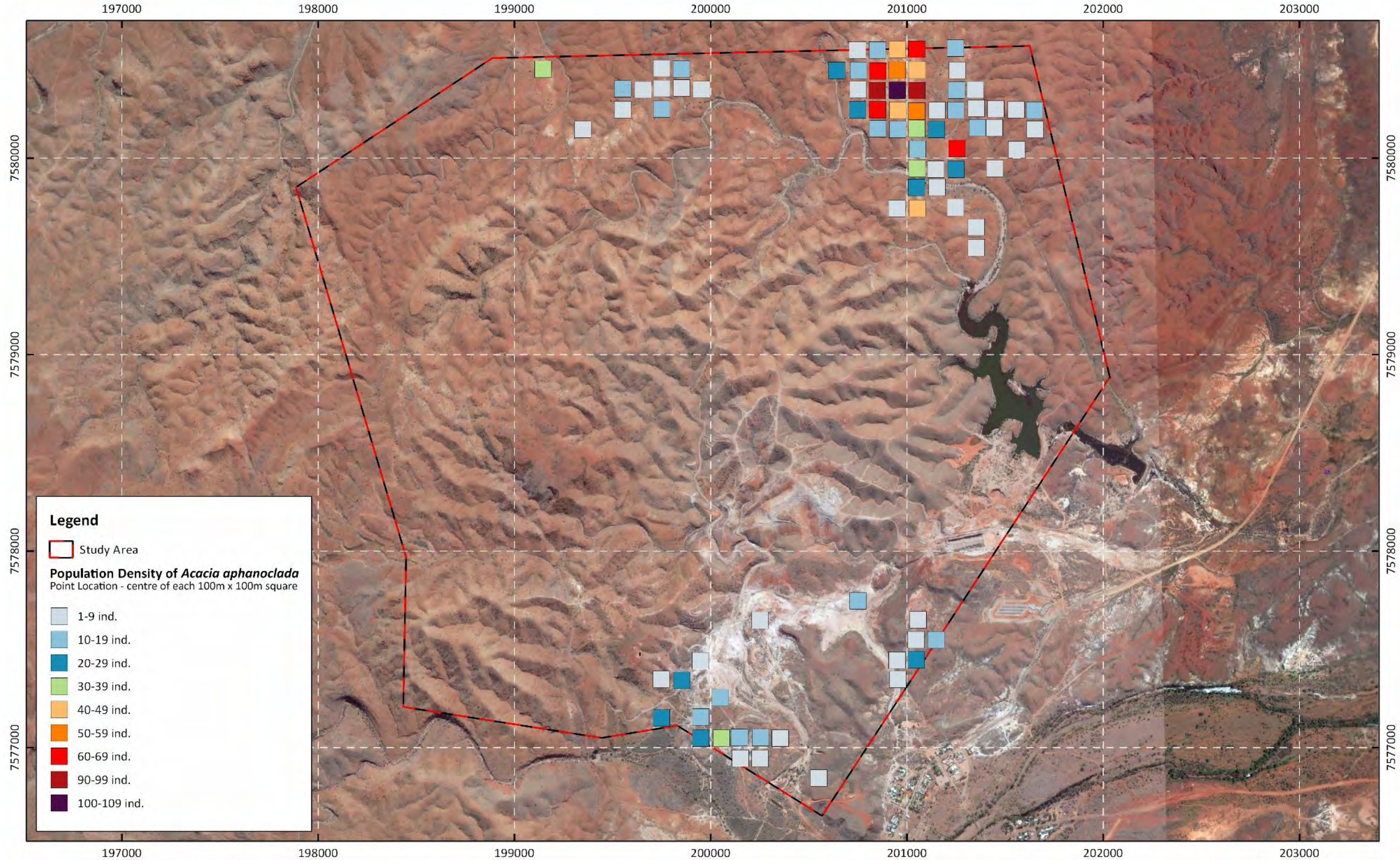


Author: Bridget Watkins	Project Name:	**Figure 7**	Figure Num: 7
Drawn: Lewis Trotter		**Location of Priority Flora**	Scale: 1 : 17000
Client: Novo Resources	**Beatons Creek Gold Project**	0 0.5 1 Kilometres	Date: 18/01/2015
		N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Page Size: A3



Author: Bridget Watkins	Project Name:	**Figure 8**	0 0.5 1 Kilometres	Figure Num: 8	MMWC Environmental
Drawn: Lewis Trotter		Population Density of Acacia aphanoclada (Priority 1)		Scale: 1 : 17000	
Client: Novo Resources	Beatons Creek Gold Project		N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 18/01/2015	
				Page Size: A3	

Legend

Vegetation Association Code and

AsyAbTlTe	Scattered shrubs of *Acacia synchronicia* (broad leaf form) and *Acacia bivenosa* over open hummock grassland of *Triodia longiceps* and *Triodia epactia*
EcTsp	Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over sedgeland of *Typha domingensis*
ElAaAoAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered tall shrubs of *Acacia aphanoclada* over scattered low shrubs of *Acacia orthocarpa* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*
ElAbTeTb	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered shrubs of *Acacia bivenosa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*
ElAoAsAhTbTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia orthocarpa*, *Acacia spondylophylla* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*
ElAtGwAmTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland open shrubland of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula* and *Acacia monticola* over open hummock grassland of *Triodia epactia*
ElChAtGwImAsTe	Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over closed scrub of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Indigofera monophylla* over scattered low shrubs of *Acacia spondylophylla* over open hummock grassland of *Triodia epactia*
ElChAtGwImWvTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over high open shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Indigofera monophylla* and *Waltheria virgata* over open hummock grassland of *Triodia epactia*
ElEvAtTeCi	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Eucalyptus victrix* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* over scattered sedges of *Cyperus ixiocarpus*
ElMgAtTe	Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Melaleuca glomerata* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*
ElMgTeGlCa	Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high open shrubland of *Melaleuca glomerata* over very open herbland of *Goodenia lamprosperma* and *Chrysocephalum apiculatum*
Disturbed	Disturbed

Author: Bridget Watkins	Project Name:	**Figure 9** **Legend**	Figure Num: 9	MMWC Environmental PTY LTD
Drawn: Lewis Trotter		**Vegetation Associations**	Scale: N/A	
Client: Novo Resources	**Beatons Creek Gold Project**		Date: 28/11/2014	
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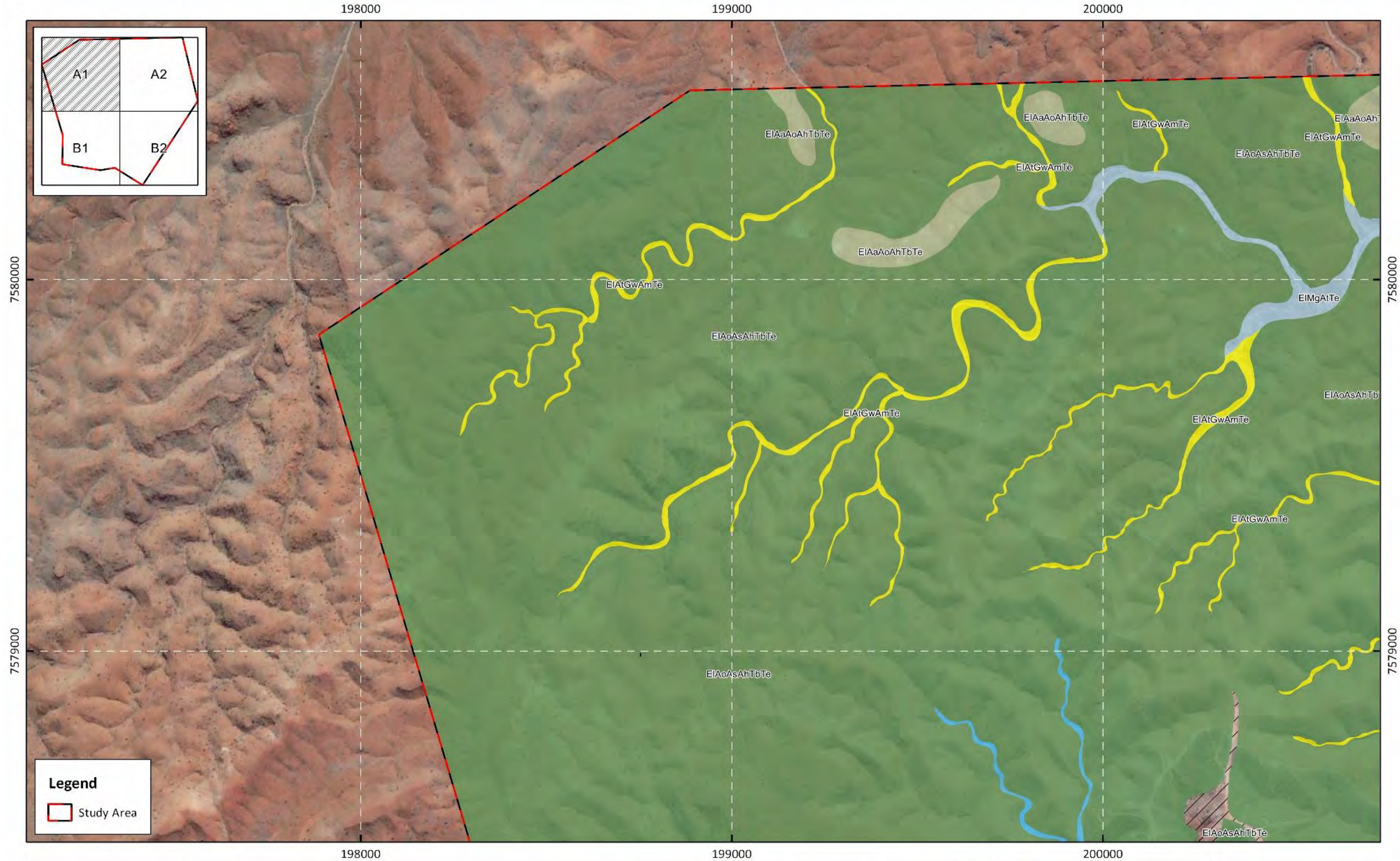

Author: Bridget Watkins	Project Name:	**Figure 9** **Map A1** **Vegetation Associations**	0 0.25 0.5 Kilometres	Figure Num: 9
Drawn: Lewis Trotter				Scale: 1 : 9000
Client: Novo Resources	**Beatons Creek Gold Project**		N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014
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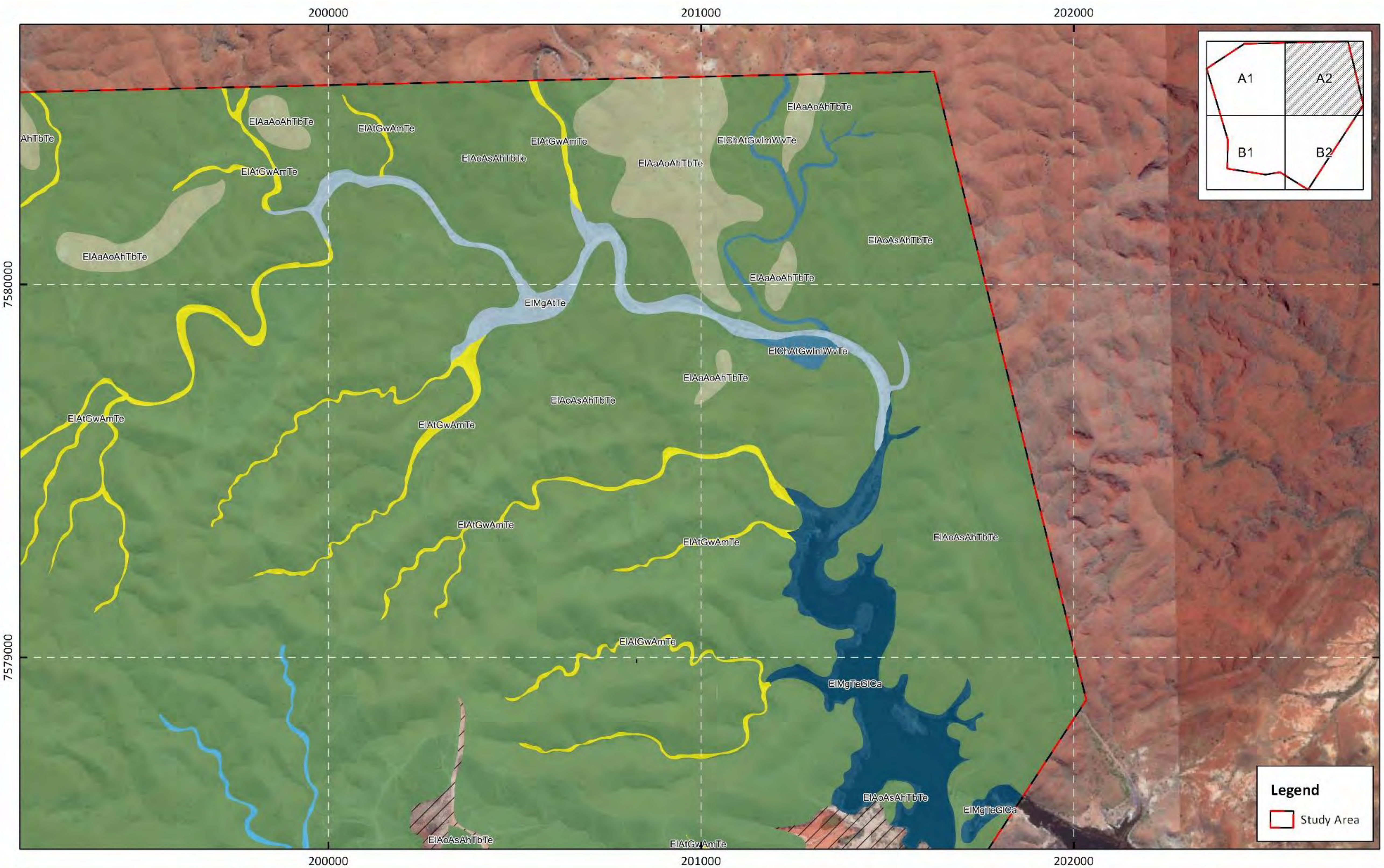
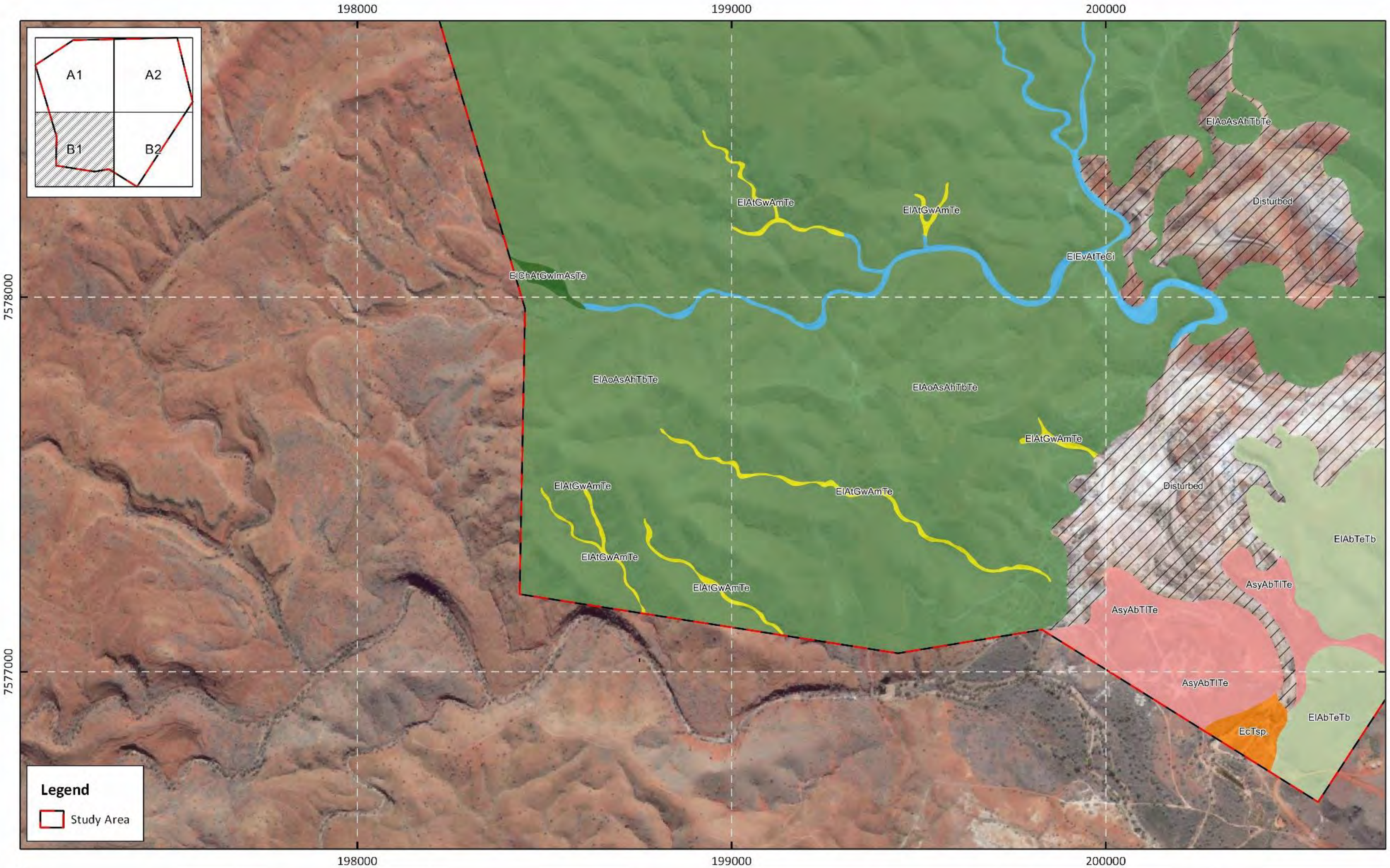
MMWC Environmental



Author: Bridget Watkins	Project Name: Beatons Creek Gold Project	**Figure 9** **Map A2** **Vegetation Associations**	Figure Num: 9
Drawn: Lewis Trotter		0 0.25 0.5 Kilometres	Scale: 1 : 9000
Client: Novo Resources		N Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014
			Page Size: A3

MMWC Environmental



Author: Bridget Watkins	Project Name: Beatons Creek Gold Project	**Figure 9 Map B1 Vegetation Associations**	Figure Num: 9
Drawn: Lewis Trotter		0 0.25 0.5 Kilometres	Scale: 1 : 9000
Client: Novo Resources		N Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014
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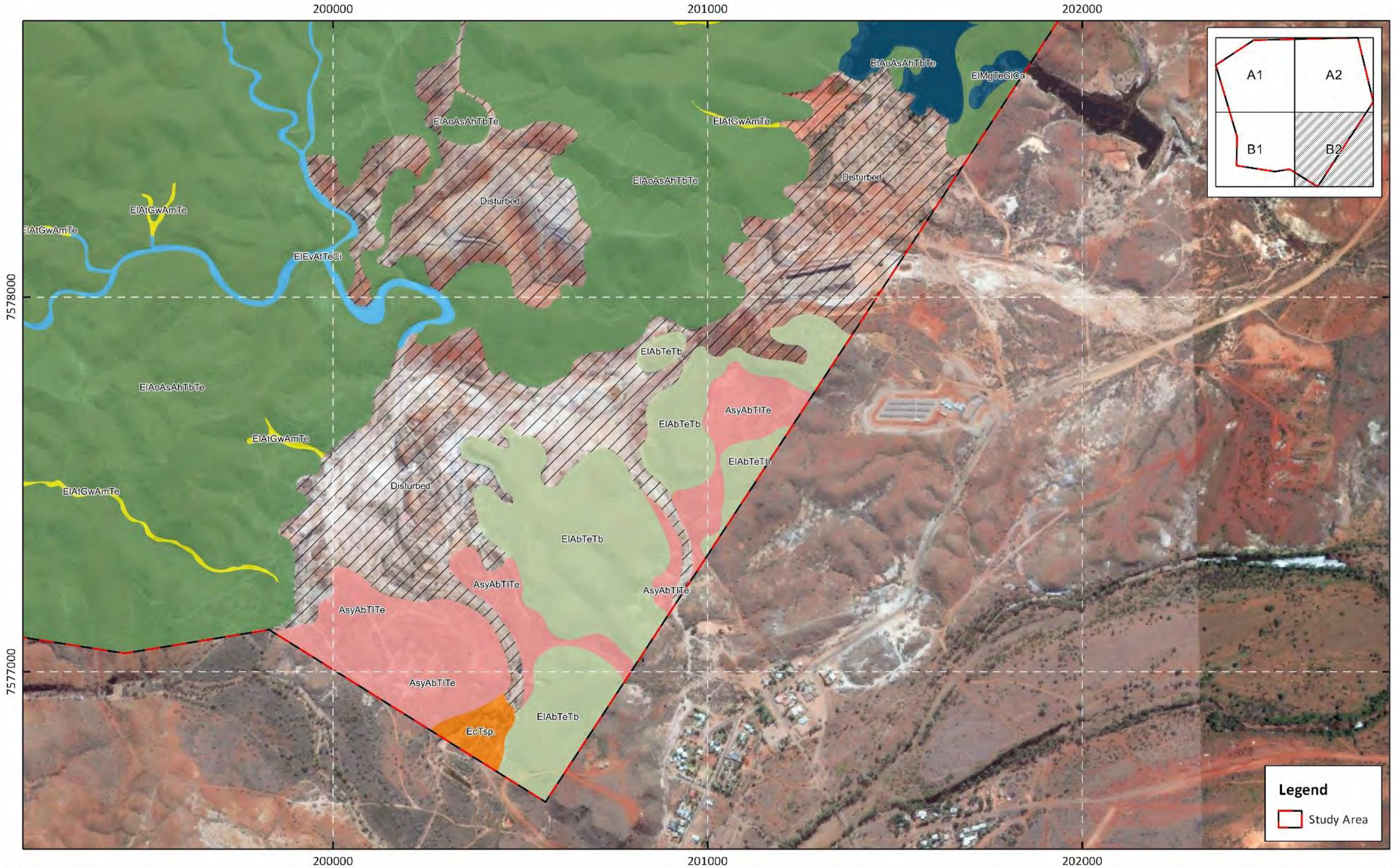
MMWC Environmental PTY LTD

MMWC Environmental PTY LTD



Author:	Bridget Watkins	Project Name:	**Figure 9**	0 0.25 0.5 Kilometres	Figure Num:	9
Drawn:	Lewis Trotter		**Map B2**		Scale:	1 : 9000
Client:	Novo Resources	**Beatons Creek Gold Project**	**Vegetation Associations**	N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date:	25/11/2014
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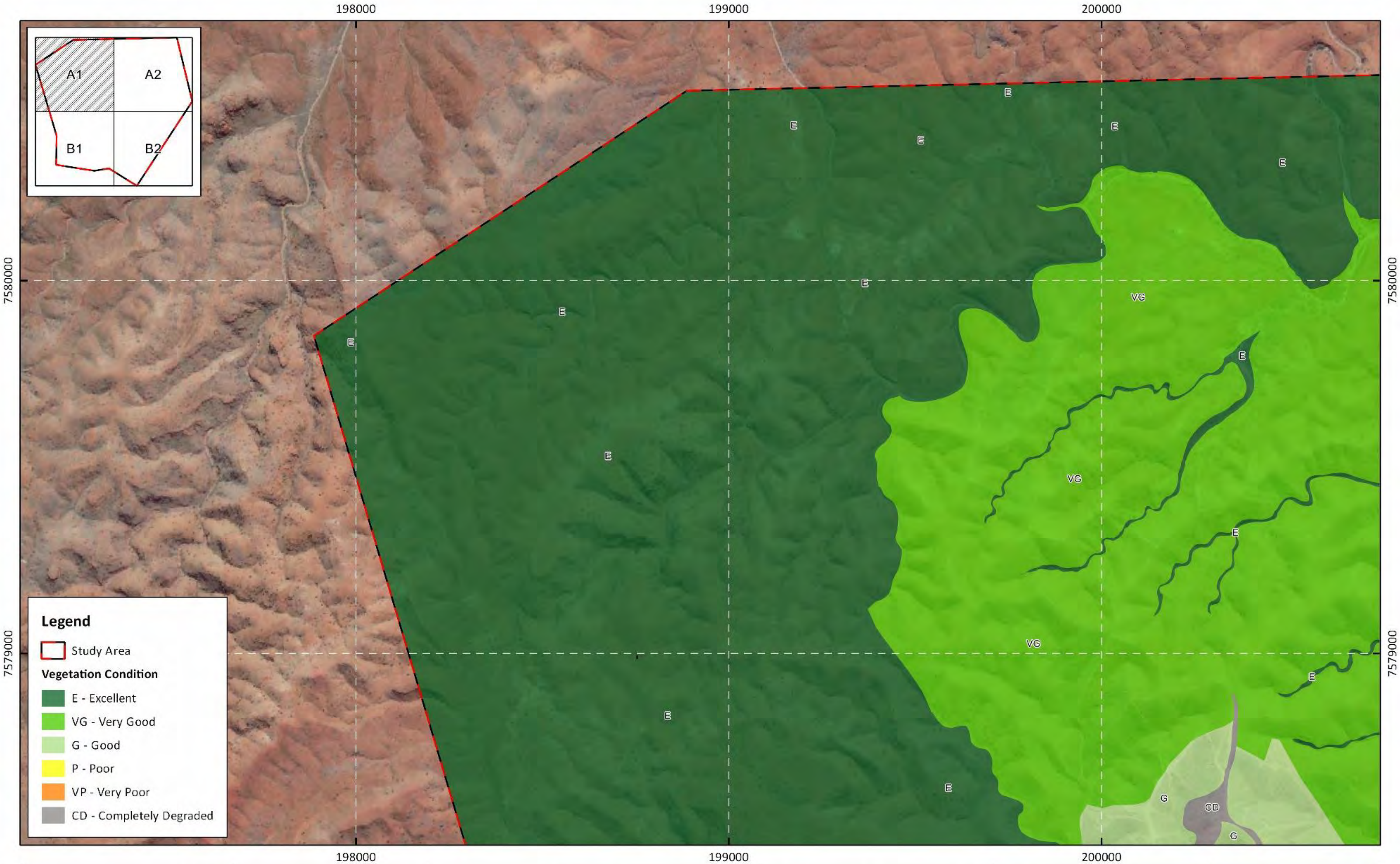
MMWC Environmental PTY LTD



Author: Bridget Watkins	Project Name:	**Figure 10**	0 0.25 0.5 Kilometres	Figure Num: 10
Drawn: Lewis Trotter		**Map A1**		Scale: 1 : 9000
Client: Novo Resources	**Beatons Creek Gold Project**	**Vegetation Condition**	N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014
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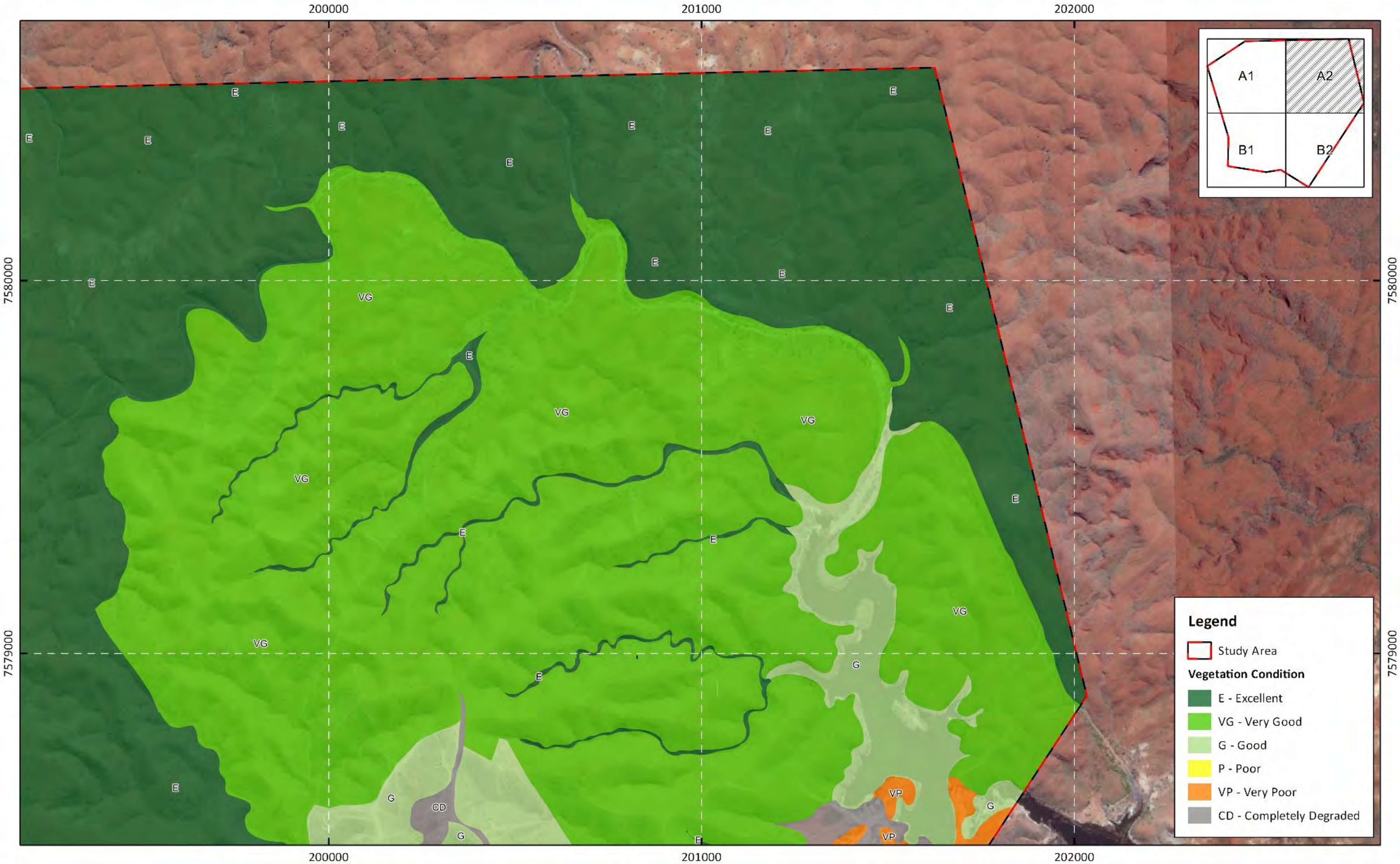

Author: Bridget Watkins	Project Name:	**Figure 10**	0 0.25 0.5 Kilometres	Figure Num: 10	MMWC Environmental
Drawn: Lewis Trotter		**Map A2**		Scale: 1 : 9000	
Client: Novo Resources	**Beatons Creek Gold Project**	**Vegetation Condition**	N — Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014	
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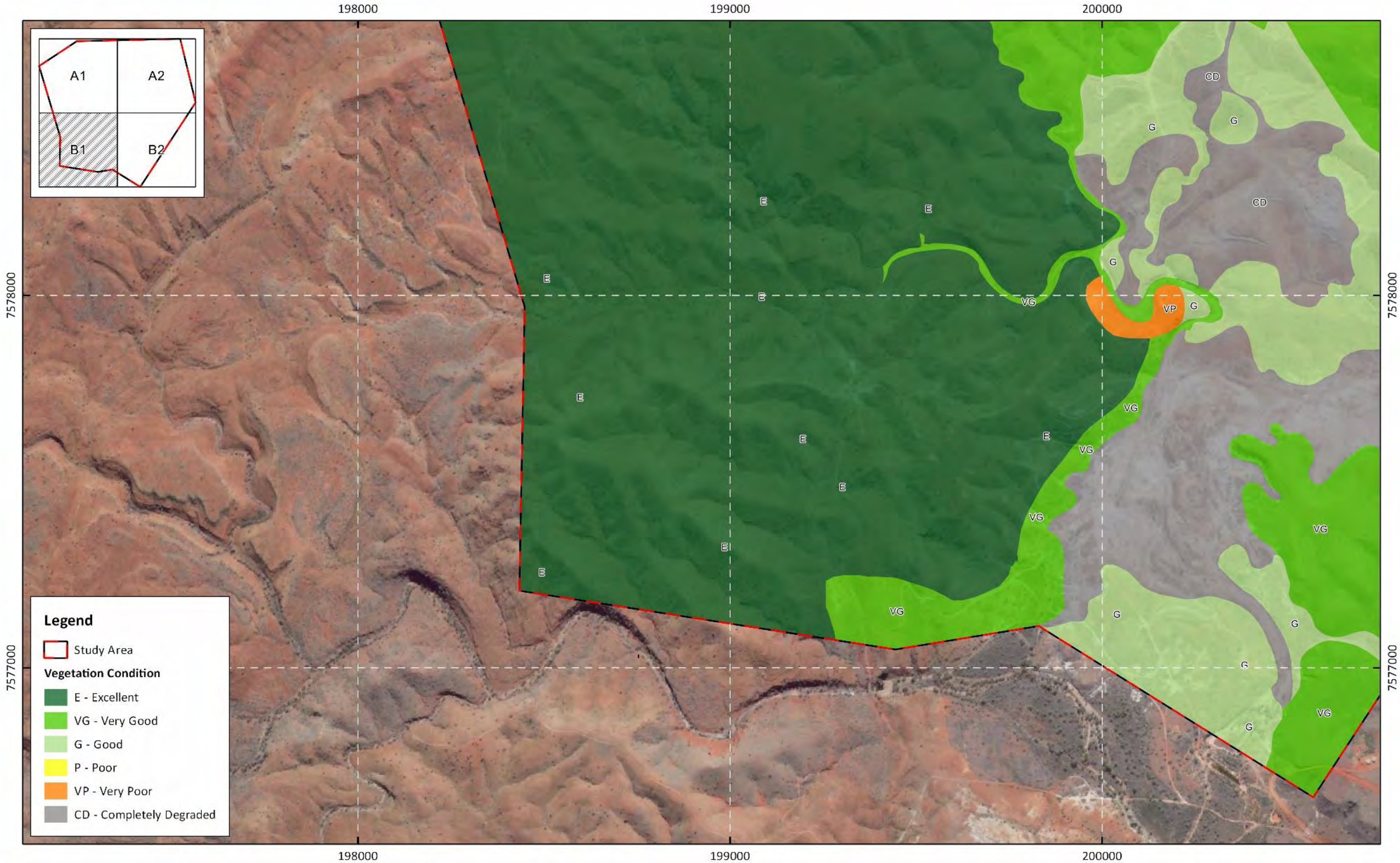
MMWC Environmental



Author: Bridget Watkins	Project Name:	**Figure 10**	0 0.25 0.5 Kilometres	Figure Num: 10	MMWC Environmental
Drawn: Lewis Trotter		**Map B1**		Scale: 1 : 9000	
Client: Novo Resources	**Beatons Creek Gold Project**	**Vegetation Condition**	N Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014	
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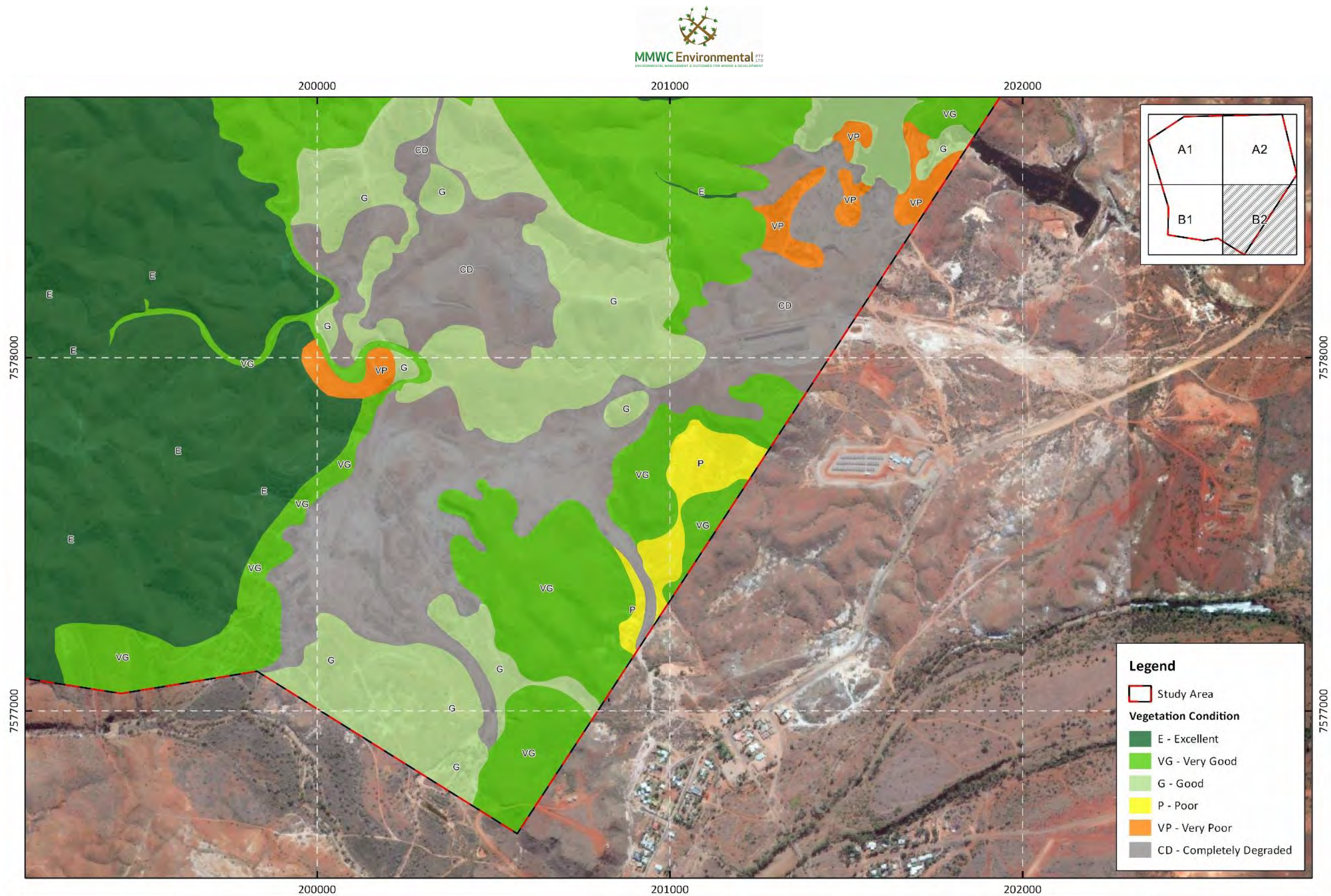

Author: Bridget Watkins	Project Name:	**Figure 10**	0 0.25 0.5 Kilometres	Figure Num: 10	MMWC Environmental
Drawn: Lewis Trotter		**Map B2**		Scale: 1 : 9000	
Client: Novo Resources	**Beatons Creek Gold Project**	**Vegetation Condition**	N Grid based on UTM Projection GDA 1994 MGA Zone 51	Date: 25/11/2014	
				Page Size: A3	

APPENDIX A

DEFINITION OF CONSERVATION CODES FOR THREATENED AND PRIORITY FLORA

A1: Categories of Threatened and Priority Flora (WC Act)

Conservation Code	Category
X	**Presumed Extinct Flora (Declared Rare Flora – Extinct)** "Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the *Wildlife Conservation Act 1950*)."
T	**Threatened Flora (Declared Rare Flora – Extant)** "Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*)." "Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria: • CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild; • EN: Endangered – considered to be facing a very high risk of extinction in the wild; • VU: Vulnerable – considered to be facing a high risk of extinction in the wild."
P1	**Priority One: Poorly-known taxa** "Taxa which are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes."
P2	**Priority Two: Poorly-known taxa** "Taxa which are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes."
P3	**Priority Three: Poorly-known taxa** "Taxa which are known from collections or sight records from several localities not under imminent threat, or few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them."

Conservation Code	Category
P4	**Priority Four: Rare, Near Threatened and other taxa in need of monitoring** **a. Rare.** "Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands." **b. Near Threatened.** "Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable." **c.** "Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy."
P5	**Priority Five: Conservation Dependent taxa** "Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years."

A2: Categories of Threatened Flora Species (EPBC Act)

Category Code	Category
Ex	**Extinct** Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX B

DEFINITION OF CONSERVATION CODES FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

B1: Threatened Ecological Communities

Presumed Totally Destroyed (PD)
An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B); A) Records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats **or** B) All occurrences recorded within the last 50 years have since been destroyed.
Critically Endangered (CR)
An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and **either or both** of the following apply (i or ii) i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years) ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years) ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years)

Endangered (EN)
An ecological community will be listed as **Endangered** when it has been adequately surveyed and is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following (A, B, C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and **either or both** of the following apply (i or ii) i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years) ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years) ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).
Vulnerable (VU)
An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is facing a high risk of total destruction in the medium to long term future. This will be determined by it meeting **any one or more** of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated. B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

B2: Priority Ecological Communities

Priority One
Poorly known ecological communities Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two
Poorly known ecological communities. Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three - Poorly known ecological communities
(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four
Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five
Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Source: Department of Parks and Wildlife (2013). *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*.

APPENDIX C

ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

Criteria used for Ranking Environmental Weeds

The Weed Prioritisation Process for the DPaW contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity. These criteria are as follows:

- Potential Distribution: Area of potential habitat in the Region that could be occupied or the area at risk of invasion by the weed.
- Current Distribution: Area of habitat in the Region currently occupied by the weed, in relation to the habitat that it could invade.
- Ecological Impact: Impact of species within the Region, from low impact (causes minimal disruption to ecological processes or loss of biodiversity) to high (causes acute disruption of ecological processes, dominates and/or significantly alters vegetation structure, composition and function of ecosystems).
- Invasiveness: Rate of spread of a weed in native vegetative, encompassing factors of establishment, reproduction and long distance dispersal (>100m).
- Feasibility of Control: The longer a coordinated control program takes to achieve its desired goal, the more expensive and less feasible it becomes. Is it feasible to eradicate or at least contain the infestation?

Source: Department of Parks and Wildlife [DPaW] (2013). *Weed Prioritisation Process for DPaW: An integrated approach to Weed Management on DPaW-managed lands in WA*.

Standard Meanings of Declared Plant Categories

Under the Biosecurity and Agriculture Management Act 2007 (the BAM Act), all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management).

- C1 Category (Exclusion): Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
- C2 Category (Eradication): Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
- C3 Category (Management): Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Source: Department of Agriculture and Food, Western Australia [DAFWA] (2014). *Western Australian Organism List*. Online: http://www.biosecurity.wa.gov.au/western-australian-organism-list-waol

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APPENDIX D

VEGETATION ASSOCIATION CLASSIFICATION MATRIX

Vegetation Classifications for the Pilbara based on Specht (1970) with modification by Aplin (1979) and Trudgen (2002)

	Under 2%	2-10%	10-30%	30-70%	70-100%
Trees over 30m	Scattered Tall Trees	High Open woodland	High Woodland	High Open Forest	High Closed Forest
Trees 10-30m	Scattered Trees	Open Woodland	Woodland	Open Forest	Closed Forest
Trees under 10m	Scattered Low Trees	Low Open Woodland	Low woodland	Low Open Forest	Low Closed Forest
Shrubs 2-5m	Scattered Tall Shrubs	High Open Shrubland	High Shrubland	Open Scrub	Closed Shrub
Shrubs 1-2m	Scattered Shrubs	Open Shrubland	Shrubland	Open Heath	Closed Heath
Shrubs under 1m	Low scattered Shrubs	Low Open Shrubland	Low Shrubland	Low Open Heath	Low Closed Heath
Grasses	Scattered Grasses	Very open Grassland	Open Grassland	Grassland	Closed Grassland
Herbs	Scattered Herbs	Very Open Herbland	Open Herbland	Herbland	Closed Herbland
Sedges	Scattered Sedges	Very Open Sedgeland	Open Sedgeland	Sedgeland	Closed Sedgeland

APPENDIX E

VEGETATION CONDITION SCALE

Condition Code	Definition
E	**Excellent** Pristine or nearly so, no obvious signs of damage caused by the activities of European man.
VG	**Very Good** Some relatively slight signs of damage caused by the activities of European man, e.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* species, or occasional vehicle tracks.
G	**Good** More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.
P	**Poor** Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* species.
VP	**Very Poor** Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.
D	**Completely Degraded** Areas that are completely or almost completely without native species in the structure of their vegetation, e.g. areas that are cleared or “parkland cleared” with their flora comprising weed or crop species with isolated native trees or shrubs.

Source: Trudgen, ME (1991). *Vegetation Condition Scale*. In: *National Trust (WA) 1993 Urban Bushland Policy*. National trust of Australia (WA), Wildflower Society of Western Australia Inc. & the Tree Society Inc. Perth, Western Australia.

APPENDIX F

FLORA QUADRAT AND RELEVÉ DATA SHEETS

Beaton's Creek Nullagine Novo Resources **Site** BC01

Described by BW **Date** 6/09/2014 **Type** Q 120 x 10 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198888 mE 7580143 mN

Habitat Creek line

Soil Pale brown sand, river gravel and stones

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia epactia* over scattered tussock grasses of *Eriachne mucronata*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 70%
Litter cover: 1% Logs; 2% Twigs; 6% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	Assoc.	0.5 m	BC02.04
Acacia orthocarpa	+	0.4 m	BC06.06
Acacia pyrifolia var. *pyrifolia*	+	1-3 m	NC
Acacia spondylophylla	+	0.3 m	BC02.03
Acacia tumida var. *pilbarensis*	20%	1-2 m	BC01.01
Corchorus parviflorus	Assoc.	0.4 m	BC01.02
Cymbopogon ambiguus	Assoc.	0.6 m	NC
Dampiera candicans	+	0.6 m	NC
Dodonaea coriacea	+	0.4 m	BC02.09
Eriachne benthamii	Assoc.	0.4 m	BC57.03
Eriachne mucronata	1%	0.4 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	2%	2-6 m	NC
Gompholobium oreophilum	+	0.6 m	BC02.06
Grevillea wickhamii subsp. *hispidula*	4%	1-2 m	NC
Melaleuca glomerata	Assoc.	1.6 m	BC57.01
Pluchea dentex	+	0.4 m	BC48.03
Senna glutinosa subsp. *glutinosa*	Assoc.	1.2 m	NC
Stemodia viscosa	Assoc.	0.4 m	HA30
Triodia epactia	20%	0.5 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BC02

Described by BW **Date** 3/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198207 mE 7579343 mN

Habitat Low hills

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* with scattered *Corymbia hamersleyana* over low open shrubland of *Acacia hilliana*, *Acacia spondylophylla* and *Acacia adoxa* var. *adoxa* over very open hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 90%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Old quad bike tracks nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	1%	0.4 m	BC02.05	
Acacia hilliana	3%	0.5 m	BC02.01	
Acacia monticola	+	1-2 m	BC02.04	
Acacia pyrifolia var. *pyrifolia*	+	1 m	NC	
Acacia spondylophylla	2%	0.5 m	BC02.03	
Corymbia hamersleyana	+	2-3 m	NC	
Dodonaea coriacea	Assoc.	0.2 m	BC02.09	
Eucalyptus leucophloia subsp. *leucophloia*	2%	2-5 m	NC	
Gompholobium oreophilum	+	0.5 m	BC02.06	
Goodenia stobbsiana	+	0.2 m	NC	Regrowth
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC	
Senna glaucifolia	+	1.5 m	BC02.02	
Triodia brizoides	4%	0.4 m	BC02.08	
Triodia epactia	3%	0.4 m	BC02.07	

Beaton's Creek Nullagine Novo Resources **Site** BC03

Described by HA **Date** 3/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198462 mE 7578835 mN

Habitat Low hills

Soil Shallow brown loam

Rock Type Quartz scree

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over open shrubland of *Acacia orthocarpa* over low open shrubland of *Acacia hilliana* over hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 55%
Litter cover: + % Logs; 1% Twigs; 1% Leaves
Disturbance: Tracks nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.3 m	NC	
Acacia adsurgens	+	1.1 m	BC03.02	
Acacia hilliana	2%	0.4 m	BC37.04	
Acacia monticola	+	1 m	BC56.02	
Acacia orthocarpa	3%	1.2 m	BC37.02	
Acacia sp.	+	3 m	BC03.03	Hybrid
Acacia spondylophylla	+	0.5 m	BC37.06	
Bulbostylis barbata	+	0.1 m	BC03.05	
Corchorus parviflorus	+	0.2 m	BC56.10	
Dodonaea coriacea	+	0.6 m	BC37.03	
Eucalyptus leucophloia subsp. *leucophloia*	7%	5 m	NC	
Gompholobium oreophilum	+	1 m	BC56.07	
Goodenia microptera	+	0.1 m	BC03.08	
Goodenia stobbsiana	+	0.3 m	NC	
Grevillea wickhamii subsp. *hispidula*	+	0.8 m	BC56.06	
Indigofera monophylla	+	0.3 m	BC03.04	
Mollugo molluginea	(+)	0.1 m	NC	
Pluchea tetranthera	Assoc.	0.4 m	BC03.07	
Senna glaucifolia	+	1.5 m	BC02.02	
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	+	0.4 m	NC	
Tephrosia supina	Assoc.	0.4 m	BC03.06	
Triodia brizoides	25%	0.5 m	BC03.01	
Triodia epactia	20%	0.3 m	BC56.03	

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Beaton's Creek Nullagine Novo Resources   Site   BC04

Described by BW   **Date** 5/09/2014   **Type** Q   50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51   198693 mE   7578344 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* with scattered *Corymbia hamersleyana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 85%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.3 m	BC02.05	
Acacia hilliana	+	0.3 m	BC02.01	
Acacia monticola	+	1 m	BC02.04	
Acacia orthocarpa	Assoc.	0.4 m	BC06.06	
Acacia pruinocarpa	+	0.5 m	NC	
Acacia pyrifolia var. *pyrifolia*	+	1.2 m	NC	
Acacia retivenea subsp. *clandestina*	Assoc.	0.6 m	BC49.02	Fire regrowth
Acacia spondylophylla	+	0.3 m	BC02.03	
Corymbia hamersleyana	Assoc.	3 m	NC	
Dodonaea coriacea	+	0.4 m	BC02.09	
Eriachne mucronata	+	0.3 m	NC	
Eucalyptus leucophloia subsp. *leucophloia*	3%	2-4 m	NC	
Gompholobium oreophilum	+	0.4 m	BC02.06	
Goodenia stobbsiana	+	0.2 m	NC	
Goodenia triodiophila	+	0.3 m	NC	
Grevillea wickhamii subsp. *hispidula*	Assoc.	1.4 m	NC	
Senna glaucifolia	+	0.8 m	BC02.02	
Triodia brizoides	6%	0.4 m	BC02.08	
Triodia epactia	6%	0.4 m	BC02.07	

Beaton's Creek Nullagine Novo Resources **Site** BC05

Described by HA **Date** 4/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199473 mE 7578126 mN

Habitat Medium drainage line

Soil Skeletal river soils with river stones

Vegetation Scattered shrubs of *Acacia tumida* var. *pilbarensis* over scattered sedges of *Cyperus ixiocarpus* over very open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 90%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia monticola	+	0.5 m	BC56.02	
Acacia orthocarpa	+	1 m	BC37.02	
Acacia tumida var. *pilbarensis*	1%	1.2 m	BC56.01	
Cassytha capillaris	+	0.3 m	HA24b	
Corchorus parviflorus	+	0.8 m	BC56.10	
Cymbopogon ambiguus	+	1 m	NC	
Cyperus hesperius	+	0.5 m	BC56.14	
Cyperus ixiocarpus	1%	0.5 m	HA28b	
Dodonaea coriacea	+	0.5 m	BC37.03	
Eragrostis cumingii	+	0.1 m	BC05.03	
Eriachne mucronata	+	0.3 m	BC56.05	
Eucalyptus victrix	+	1.2 m	NC	Juvenile
Euphorbia australis var. *subtomentosa*	+	Creeper	BC05.02	
Ficus brachypoda	+	3 m	HA11	
Grevillea wickhamii subsp. *hispidula*	+	0.5 m	BC56.06	
Indigofera monophylla	+	0.8 m	NC	
Pluchea dentex	+	0.3 m	HA18	
Ptilotus fusiformis	(+)	0.3 m	NC	
? *Sauropus* sp.	+	0.1 m	BC05.01	
Senna glutinosa subsp. *glutinosa*	+	0.5 m	NC	
Trichodesma zeylanicum var. *zeylanicum*	+	1 m	NC	
Triodia epactia	10%	0.4 m	BC56.03	

Beaton's Creek Nullagine Novo Resources **Site** BC06

Described by BW **Date** 3/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198448 mE 7579712 mN

Habitat Creek line

Soil Red brown sand with ?salt crusting

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 90%
Litter cover: + % Logs; 2% Twigs; 4% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia colei var. *colei*	Assoc.	1.5 m	BC06.07
Acacia monticola	+	1-2 m	BC02.04
Acacia orthocarpa	Assoc.	1.3 m	BC06.06
Acacia spondylophylla	Assoc.	0.5 m	BC02.03
Acacia tumida var. *pilbarensis*	4%	2-3 m	BC06.01
Corchorus parviflorus	+	0.3 m	BC06.04
Eriachne mucronata	+	0.2 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	+	3-4 m	NC
Gompholobium oreophilum	Assoc.	0.4 m	BC02.06
Goodenia stobbsiana	+	0.1 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1-3 m	NC
Petalostylis cassioides	Assoc.	0.4 m	BC06.05
Solanum phlomoides	+	0.2 m	BC06.02
Stemodia grossa	+	0.05 m	NC
Triodia epactia	6%	0.4 m	BC06.03

Beaton's Creek Nullagine Novo Resources **Site** BC07

Described by HA **Date** 6/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199373 mE 7580117 mN

Habitat Footslope / low undulating hills

Soil Shallow brown loam

Rock Type Quartz

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia bivenosa* and *Acacia orthocarpa* over hummock grassland of *Triodia brizoides*, *Triodia longiceps* and *Triodia epactia* over scattered herbs of *Goodenia cusackiana*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 65%
Litter cover: + % Logs; +1% Twigs; + % Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.3 m	NC	
Acacia aphanoclada	+	2.1 m	BC07.03	5 individuals
Acacia bivenosa	2%	0.7 m	NC	
Acacia orthocarpa	1%	0.5 m	BC37.02	
Acacia pyrifolia var. *pyrifolia*	+	0.5 m	NC	
Acacia spondylophylla	+	0.5 m	BC37.06	
Bonamia media	+	0.05 m	NC	
Bulbostylis barbata	(+)	0.1 m	BC03.05	Dead
Eriachne mucronata	+	0.3 m	BC56.05	
Eucalyptus leucophloia subsp. *leucophloia*	1%	4 m	NC	
Goodenia cusackiana	+	0.3 m	HA26	
Goodenia stobbsiana	+	0.3 m	NC	
Goodenia triodiophila	+	0.2 m	HA08	
Grevillea wickhamii subsp. *hispidula*	+	0.5 m	BC56.06	
Mollugo molluginea	+	0.1 m	NC	
Ptilotus calostachyus	+	0.5 m	NC	
Senna glaucifolia	+	1.2 m	BC02.02	
Triodia brizoides	18%	0.3 m	BC07.02	
Triodia epactia	5%	0.4 m	BC56.03	
Triodia longiceps	12%	0.4 m	BC07.01	

Beaton's Creek Nullagine Novo Resources **Site** BC08

Described by BW **Date** 7/09/2014 **Type** Q 120 x 20 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200793 mE 7579987 mN

Habitat Creek line

Soil Pale brown sand with river stones

Vegetation High shrubland of *Melaleuca glomerata* and *Acacia tumida* var. *pilbarensis* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 70%
Litter cover: 1% Logs; 3% Twigs; 5% Leaves
Disturbance: Track up the centre of the creek line
Notes: Quadrat located in a denser section of the creek line with a *Melaleuca* island

SPECIES LIST:

	Cover	Height	Specimen
Acacia maitlandii	+	0.5 m	NC
Acacia trachycarpa x ?*tumida*	+	2-3 m	BC08.01
Acacia tumida var. *pilbarensis*	7%	2-3 m	NC
Calandrinia quadrivalvis	+	0.1 m	HA49
Cassytha capillaris	+	0.2 m	NC
Corchorus parviflorus	+	0.4 m	BC01.02
Corymbia candida subsp. *dipsodes*	Assoc.	8 m	BC08.03
Cyperus ixiocarpus	+	0.6 m	BC57.04
Eriachne mucronata	+	0.4 m	NC
Euphorbia boophthona	+	0.4 m	BC08.02
Gonocarpus ephemerus	+	0.2 m	BC12.04
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Hybanthus aurantiacus	+	0.4 m	NC
Indigofera monophylla	+	0.8 m	NC
Melaleuca glomerata	7%	2-3 m	BC57.01
Phyllanthus maderaspatensis	+	0.4 m	BC12.01
Pluchea dentex	+	0.4 m	BC48.03
Triodia epactia	15%	0.5 m	BC02.07
Waltheria virgata	+	0.6 m	BC09.01

Beaton's Creek Nullagine Novo Resources **Site** BC09

Described by BW **Date** 7/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201281 mE 7579832 mN

Habitat Flood plain / river bank

Soil Sandy loam

Vegetation Low open woodland of *Corymbia hamersleyana* over high open shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Indigofera monophylla* over low open shrubland of *Corchorus parviflorus*, *Waltheria virgata* and *Acacia trachycarpa* over very open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 70%
Litter cover: 1% Logs; 2% Twigs; 5% Leaves
Disturbance: Old diggings, mounds and trenches from previous surface gold mining

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia bivenosa	+	0.6 m	NC	
Acacia maitlandii	+	0.5 m	NC	
Acacia trachycarpa	1%	0.6 m	NC	
Acacia trachycarpa x ?*tumida*	+	2-3 m	BC09.05	
Acacia tumida var. *pilbarensis*	5%	2-3 m	NC	
Aristida holathera var. *holathera*	(+)	0.3 m	NC	Dead
Bonamia rosea	+	0.4 m	NC	
Calocephalus beardii	+	0.05 m	BC09.02	
Corchorus parviflorus	2%	0.7 m	BC01.02	
Corymbia hamersleyana	2%	4-6 m	NC	
Eragrostis eriopoda	(+)	0.2 m	HA66	Dead
Eremophila latrobei subsp. *latrobei*	+	2-3 m	BC09.03	
Grevillea wickhamii subsp. *hispidula*	1%	2-3 m	NC	
Hibiscus sturtii var. *campylochlamys*	+	0.2 m	NC	
Indigofera monophylla	1%	1-2 m	NC	
Pluchea dentex	+	0.4 m	BC48.03	
Pluchea tetranthera	+	0.4 m	BC55.02	
Podolepis capillaris	+	0.4 m	BC09.04	
Santalum lanceolatum	+	1 m	NC	
Scaevola browniana subsp. *browniana*	+	0.4 m	NC	
Senna notabilis	+	0.2 m	NC	
Triodia epactia	7%	0.6 m	BC02.07	
Waltheria indica	+	0.2 m	NC	
Waltheria virgata	1%	0.5 m	BC09.01	

Beaton's Creek Nullagine Novo Resources **Site** BC11

Described by HA **Date** 8/09/2014 **Type** Q 120 x 20 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201119 mE 7579565 mN

Habitat Creek bed

Soil Brown sand with creek stones

Vegetation High shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 85%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Tracks nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia orthocarpa	+	0.4 m	BC37.02	
Acacia spondylophylla	+	0.4 m	BC37.06	
Acacia tumida var. *pilbarensis*	20%	2.2 m	BC56.01	
Corymbia hamersleyana	+	3 m	NC	
Dampiera candicans	+	0.5 m	NC	
Dodonaea coriacea	+	0.4 m	BC37.03	
Eucalyptus leucophloia subsp. *leucophloia*	+	1.5 m	NC	Juvenile
Gompholobium oreophilum	+	0.8 m	BC56.07	
Goodenia stobbsiana	(+)	0.2 m	NC	
Grevillea wickhamii subsp. *hispidula*	1%	2.5 m	NC	
Hibiscus sturtii var. *campylochlamys*	+	0.3 m	NC	
Petalostylis cassioides	+	1 m	HA12	
Senna glutinosa subsp. *glutinosa*	+	1.5 m	NC	
Triodia epactia	15%	0.5 m	BC56.03	

Beaton's Creek Nullagine Novo Resources   Site BC12

Described by BW   **Date** 6/09/2014 **Type** Q   80 x 30 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51   200270 mE   7580231 mN

Habitat Creek line

Soil Pale brown sand, river gravel and stones

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Melaleuca glomerata* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 90%
Litter cover: + % Logs; 2% Twigs; 7% Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia maitlandii	+	0.5 m	NC	
Acacia tumida var. *pilbarensis*	6%	1-2 m	BC12.03	
Cassytha capillaris	+	0.2 m	NC	
Corchorus parviflorus	+	0.4 m	BC01.02	
Cymbopogon ambiguus	+	0.6 m	NC	
Cyperus hesperius	(+)	0.4 m	BCR34.02	Dead
Dampiera candicans	+	0.4 m	NC	
Eriachne mucronata	+	0.4 m	NC	
Eucalyptus leucophloia subsp. *leucophloia*	2%	4-6 m	NC	
Gonocarpus ephemerus	+	0.2 m	BC12.04	
Grevillea wickhamii subsp. *hispidula*	1%	2-3 m	NC	
Indigofera monophylla	+	0.8 m	BC12.02	
Melaleuca glomerata	8%	2-3 m	BC57.01	
Petalostylis cassioides	+	0.4 m	BC59.02	
Phyllanthus maderaspatensis	+	0.2 m	BC12.01	
Pluchea dentex	+	0.4 m	BC48.03	
Senna glutinosa subsp. *glutinosa*	+	1.2 m	NC	
Solanum ? horridum	+	0.2 m	BCR34.05	
Stemodia viscosa	+	0.4 m	HA30	
Triodia epactia	8%	0.5 m	BC02.07	

Beaton's Creek Nullagine Novo Resources **Site** BC13

Described by HA **Date** 6/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200395 mE 7579686 mN

Habitat Creek line

Soil Light brown coarse sand

Vegetation High shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Petalostylis cassioides* over very open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 90%
Litter cover: 1% Logs; 2% Twigs; 1% Leaves
Disturbance: Vehicle tracks up the centre of the creek line

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.3 m	NC
Acacia maitlandii	+	0.5 m	HA33
Acacia monticola	+	2.1 m	BC56.02
Acacia orthocarpa	+	0.5 m	BC37.02
Acacia pyrifolia var. *pyrifolia*	+	1.5 m	NC
Acacia spondylophylla	+	0.5 m	BC37.06
Acacia tumida var. *pilbarensis*	12%	2.5 m	BC13.01
Cassytha capillaris	+	0.2 m	HA24b
Corchorus parviflorus	+	0.8 m	BC56.10
Gompholobium oreophilum	+	0.5 m	BC56.07
Goodenia cusackiana	+	0.2 m	HA26
Goodenia stobbsiana	+	0.3 m	NC
Grevillea wickhamii subsp. *hispidula*	2%	2.1 m	BC56.06
Petalostylis cassioides	1%	1.2 m	BC13.02
Ptilotus calostachyus	+	1 m	NC
Triodia epactia	8%	0.5 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC14

Described by BW **Date** 7/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201024 mE 7580405 mN

Habitat Low hills

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia orthocarpa* and *Acacia hilliana* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 85%
Litter cover: + % Logs; + % Twigs; 2% Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05	
Acacia aphanoclada	+	1-4 m	BC14.	15 individuals
Acacia hilliana	1%	0.3 m	BC02.01	
Acacia orthocarpa	1%	0.4 m	BC06.06	
Acacia spondylophylla	+	0.3 m	BC02.03	
Eucalyptus leucophloia subsp. *leucophloia*	2%	3-6 m	NC	
Gompholobium oreophilum	+	0.4 m	BC02.06	
Goodenia cusackiana	+	0.2 m	NC	
Goodenia stobbsiana	+	0.2 m	NC	
Senna glaucifolia	+	1.2 m	BC02.02	
Senna glutinosa subsp. *luerssenii*	Assoc.	0.6 m	NC	
Triodia brizoides	8%	0.3 m	BC02.08	
Triodia epactia	5%	0.3 m	BC02.07	

Beaton's Creek Nullagine Novo Resources **Site** BC15

Described by HA **Date** 7/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201233 mE 7580268 mN

Habitat Creek bed

Soil Brown sand with creek stones

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Indigofera monophylla*, *Petalostylis cassioides* and *Waltheria virgata* over open hummock grassland of *Triodia epactia*.

Veg Condition Excellent

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia bivenosa	+	1 m	NC
Acacia maitlandii	+	1.2 m	HA33
Acacia monticola	+	0.5 m	BC56.02
Acacia orthocarpa	+	0.7 m	BC37.02
Acacia spondylophylla	+	0.5 m	BC37.06
Acacia trachycarpa x ?*tumida*	+	0.9 m	BC15.04
Acacia tumida var. *pilbarensis*	12%	2.1 m	BC56.01
Cassytha capillaris	+	0.2 m	HA24b
Corchorus parviflorus	+	1 m	BC56.10
Corymbia hamersleyana	+	3 m	NC
Dampiera candicans	+	0.3 m	NC
Eriachne benthamii	+	0.4 m	BC15.03
Eucalyptus leucophloia subsp. *leucophloia*	1%	3 m	NC
Grevillea wickhamii subsp. *hispidula*	3%	2.5 m	NC
Hibiscus sturtii var. *campylochlamys*	+	0.5 m	HA50
Hybanthus aurantiacus	+	0.2 m	NC
Indigofera monophylla	1%	1.6 m	HA10
Isotropis atropurpurea	+	0.4 m	NC
Petalostylis cassioides	1%	1 m	HA12
Phyllanthus maderaspatensis	+	0.3 m	NC
Pluchea dentex	+	0.3 m	HA18
Ptilotus fusiformis	+	0.4 m	NC
Scaevola browniana subsp. *browniana*	+	0.3 m	BC15.02
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	+	0.4 m	NC
Triodia epactia	18%	0.4 m	BC56.03
Waltheria virgata	1%	1 m	BC15.01

Beaton's Creek Nullagine Novo Resources **Site** BC16

Described by BW **Date** 8/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199625 mE 7579958 mN

Habitat Creek bank / flood plain

Soil Red brown loam with cobbles and pebbles and pale brown sand with creek stones and gravel

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over shrubland of *Acacia tumida* var. *pilbarensis* over scattered low shrubs of *Gompholobium oreophilum* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 70%
Litter cover: + % Logs; 2% Twigs; 4% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia pyrifolia var. *pyrifolia*	+	1.2 m	NC
Acacia spondylophylla	+	0.4 m	BC02.03
Acacia tumida var. *pilbarensis*	20%	1-2 m	NC
Dampiera candicans	+	0.4 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	+	3-4 m	NC
Gompholobium oreophilum	1%	0.5 m	BC02.06
Goodenia stobbsiana	+	0.2 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1 m	NC
Triodia epactia	20%	0.5 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BC20

Described by HA **Date** 8/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200028 mE 7579683 mN

Habitat Open gully

Soil Skeletal soil

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered tall shrubs of *Acacia monticola* and *Acacia tumida* var. *pilbarensis* over scattered shrubs of *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 85%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Tracks on hills nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia maitlandii	+	0.5 m	NC
Acacia monticola	0.5%	2.1 m	BC56.02
Acacia orthocarpa	+	0.5 m	BC37.02
Acacia pyrifolia var. *pyrifolia*	+	1.5 m	NC
Acacia spondylophylla	+	0.4 m	BC37.06
Acacia tumida var. *pilbarensis*	0.5%	2.2 m	BC56.01
Bulbostylis barbata	+	0.1 m	BC03.05
Dampiera candicans	+	0.6 m	NC
Eriachne mucronata	+	0.5 m	BC56.05
Eucalyptus leucophloia subsp. *leucophloia*	1%	4 m	NC
Goodenia stobbsiana	+	0.3 m	NC
Grevillea wickhamii subsp. *hispidula*	0.5%	1.2 m	NC
Senna glutinosa subsp. *glutinosa*	+	1.5 m	NC
Triodia epactia	15%	0.5 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC23

Described by HA **Date** 5/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201139 mE 7579219 mN

Habitat Hill slope / ridge

Soil Shallow red brown loam

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 50%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia pyrifolia var. *pyrifolia*	+	1.2 m	NC
Acacia tumida var. *pilbarensis*	+	1.2 m	BC56.01
Bulbostylis barbata	+	0.1 m	BC03.05
Eucalyptus leucophloia subsp. *leucophloia*	1%	3 m	NC
Grevillea wickhamii subsp. *hispidula*	+	2.5 m	BC56.06
Senna glaucifolia	+	1.5 m	BC02.02
Triodia brizoides	22%	0.3 m	BC37.01
Triodia epactia	22%	0.4 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC26

Described by BW **Date** 6/09/2014 **Type** Q 60 x 40 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200589 mE 7578636 mN

Habitat Hill slope / gully

Soil Red brown loam with cobbles and pebbles

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over open shrubland of *Acacia monticola* and *Acacia tumida* var. *pilbarensis* over scattered low shrubs of *Acacia hilliana* over hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 50%
Litter cover: + % Logs; 1% Twigs; 4% Leaves
Disturbance: Drill pad and drill tracks nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia hilliana	1%	0.4 m	BC02.01
Acacia monticola	4%	1-2 m	BC02.04
Acacia pyrifolia var. *pyrifolia*	+	1-2 m	NC
Acacia tumida var. *pilbarensis*	4%	1-2 m	NC
Corymbia deserticola subsp. *deserticola*	+	2-3 m	NC
Dampiera candicans	+	0.4 m	NC
Dodonaea coriacea	+	0.8 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	1%	3-6 m	NC
Gompholobium oreophilum	+	0.4 m	BC02.06
Goodenia stobbsiana	+	0.2 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Hakea lorea subsp. *lorea*	+	0.4 m	NC
Triodia brizoides	40%	0.4 m	BC02.08

Beaton's Creek Nullagine Novo Resources **Site** BC33

Described by HA **Date** 8/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200749 mE 7577373 mN

Habitat Hill plateau

Soil Red brown loam with cobbles and pebbles

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered low shrubs of *Acacia bivenosa* over hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 20%
Litter cover: + % Logs; 1% Twigs; 20% Leaves
Disturbance: Nil
Notes: Large areas of old dead *Triodia* hummocks

SPECIES LIST:

	Cover	Height	Specimen
Acacia acradenia	Assoc.	0.5 m	BC40.01
Acacia bivenosa	1%	0.6 m	NC
Acacia hilliana	+	0.3 m	BC02.01
Acacia tumida var. *pilbarensis*	+	2 m	NC
Cassytha capillaris	+	0.2 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	1%	3-5 m	NC
Hakea chordophylla	+	2 m	NC
Haloragis gossei var. *gossei*	+	0.2 m	BC33.
Senna glaucifolia	+	1.2 m	BC02.02
Triodia brizoides	50%	0.6 m	BC02.08
Triodia epactia	+	0.4 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BC36

Described by BW **Date** 7/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201596 mE 7579667 mN

Habitat Hill slope / crest

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over low open shrubland of *Acacia orthocarpa* and *Acacia spondylophylla* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Track nearby
Notes: Patchy burn scar over hills, Pebble mound mouse mound nearby

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia bivenosa	+	0.3 m	NC	
Acacia hilliana	+	0.4 m	BC02.01	
Acacia orthocarpa	3%	0.5 m	BC06.06	
Acacia pyrifolia var. *pyrifolia*	+	1.5 m	NC	
Acacia spondylophylla	1%	0.4 m	BC02.03	
Bulbostylis barbata	(+)	0.05 m	BC47.01	Dead
Corymbia hamersleyana	1%	3-6 m	NC	
Eucalyptus leucophloia subsp. *leucophloia*	1%	3-7 m	NC	
Gompholobium oreophilum	+	0.4 m	BC02.06	
Grevillea wickhamii subsp. *hispidula*	+	1 m	NC	
Indigofera monophylla	+	1.1 m	NC	
Mollugo molluginea	+	0.1 m	NC	
Senna glaucifolia	+	1.2 m	BC02.02	
Senna glutinosa subsp. *glutinosa*	+	1.2 m	NC	
Triodia brizoides	10%	0.5 m	BC02.08	
Triodia epactia	4%	0.4 m	BC02.07	

Beaton's Creek Nullagine Novo Resources **Site** BC37

Described by HA **Date** 3/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198676 mE 7579494 mN

Habitat Upper hill slope

Soil Red brown loam

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia hilliana* and *Acacia orthocarpa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*.

Veg Condition Very Good

Fire Age Young

Notes Bare ground: 55%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	8%	0.4 m	BC37.04
Acacia monticola	+	1.5 m	BC56.02
Acacia orthocarpa	1%	0.5 m	BC37.02
Acacia pyrifolia var. *pyrifolia*	+	0.5 m	NC
Acacia retivenea subsp. *clandestina*	+	0.9 m	BC56.04
Acacia spondylophylla	+	0.5 m	BC37.06
Corymbia deserticola subsp. *deserticola*	+	5 m	BC37.05
Dodonaea coriacea	+	0.5 m	BC37.03
Eucalyptus leucophloia subsp. *leucophloia*	1.5%	3 m	NC
Gompholobium oreophilum	+	0.6 m	BC56.07
Goodenia stobbsiana	+	0.2 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1 m	BC56.06
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	+	0.1 m	NC
Triodia brizoides	15%	0.3 m	BC37.01
Triodia epactia	25%	0.3 m	BC56.03

Beaton's Creek Nullagine Novo Resources Site BC38

Described by HA **Date** 3/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200182 mE 7578091 mN

Habitat Hill slope

Soil Shallow red brown loam

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over hummock grassland of *Triodia epactia* and *Triodia brizoides*.

Veg Condition Good

Fire Age Old

Notes Bare ground: 55%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Tracks and clearing nearby
Notes: Very dry, steep slope

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	+	2.5 m	BC56.02
Acacia pyrifolia var. *pyrifolia*	+	0.9 m	BC56.11
Acacia tumida var. *pilbarensis*	+	1.8 m	BC38.02
Eucalyptus leucophloia subsp. *leucophloia*	1%	3 m	NC
Goodenia stobbsiana	+	0.2 m	NC
Hakea lorea subsp. *lorea*	+	1.8 m	NC
Maireana tomentosa subsp. *tomentosa*	+	0.1 m	HA09
Senna glaucifolia	+	1.5	BC02.02
Triodia brizoides	15%	0.4 m	BC38.03
Triodia epactia	35%	0.4 m	BC38.01

Beaton's Creek Nullagine Novo Resources **Site** BC39

Described by HA **Date** 7/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201353 mE 7580089 mN

Habitat Low laterite hill

Soil Shallow red brown loam

Vegetation Low shrubland of *Acacia orthocarpa*, *Acacia hilliana* and *Acacia spondylophylla* over open hummock grassland of *Triodia epactia* and *Triodia brizoides*.

Veg Condition Very Good

Fire Age Young

Notes Bare ground: 80%
Litter cover: + % Logs; 1% Twigs; 1% Leaves
Disturbance: Tracks nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	4%	0.4 m	BC37.04
Acacia orthocarpa	20%	0.5 m	BC37.02
Acacia spondylophylla	1%	0.4 m	BC37.06
Corymbia hamersleyana	+	3 m	NC
Dampiera candicans	+	0.4 m	NC
Gompholobium oreophilum	2%	0.6 m	BC56.07
Goodenia stobbsiana	+	0.3 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1.2 m	BC56.06
Indigofera monophylla	+	0.5 m	HA10
Mollugo molluginea	+	0.1 m	NC
Ptilotus calostachyus	+	0.7 m	NC
Triodia brizoides	5%	0.2 m	BC37.01
Triodia epactia	15%	0.2 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC40

Described by BW **Date** 8/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200953 mE 7577737 mN

Habitat Low hill

Soil Red brown loam with cobbles and pebbles

Rock Type ? Ironstone

Vegetation Scattered shrubs of *Acacia bivenosa* over hummock grassland of *Triodia epactia* and *Triodia brizoides*.

Veg Condition Good

Fire Age Old

Notes Bare ground: 60%
Litter cover: - % Logs; + % Twigs; 2% Leaves
Disturbance: Old vehicle tracks nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia acradenia	+	1 m	BC40.01
Acacia bivenosa	+	1 m	NC
Capparis umbonata	+	0.4 m	BC40.02
Ptilotus calostachyus	+	0.4 m	NC
Triodia brizoides	5%	0.4 m	BC02.08
Triodia epactia	30%	0.4 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BC42

Described by BW **Date** 4/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199000 mE 7578995 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia hilliana*, *Acacia spondylophylla* and *Gompholobium oreophilum* over very open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Young

Notes Bare ground: 90%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Vehicle tracks nearby
Notes: Obvious fire regrowth

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.3 m	BC02.05	
Acacia hilliana	2%	0.4 m	BC02.01	
Acacia pyrifolia var. *pyrifolia*	+	1.4 m	NC	
Acacia spondylophylla	2%	0.4 m	BC02.03	
Acacia tumida var. *pilbarensis*	+	0.8 m	NC	
Bonamia media	+	0.1 m	NC	
Dampiera candicans	+	0.3 m	NC	
Dodonaea coriacea	+	0.3 m	BC02.09	
Eucalyptus leucophloia subsp. *leucophloia*	2%	2-4 m	NC	
Gompholobium oreophilum	1%	0.4 m	BC02.06	
Goodenia stobbsiana	(+)	0.2 m	NC	Dead
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC	
Senna glaucifolia	+	0.8 m	BC02.02	
Triodia brizoides	7%	0.4 m	BC49.01	
Triodia epactia	+	0.3 m	BC46.01	

Beaton's Creek Nullagine Novo Resources **Site** BC44

Described by HA **Date** 5/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198850 mE 7578520 mN

Habitat Minor drainage line

Soil Light brown coarse sand

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over high open shrubland of *Acacia monticola* and *Grevillea wickhamii* subsp. *hispidula* over open shrubland of *Acacia retivenea* subsp. *clandestina* and *Acacia tumida* var. *pilbarensis* over scattered low shrubs of *Corchorus parviflorus* over open hummock grassland of *Triodia epactia* over very open tussock grassland of *Cymbopogon ambiguus* and *Eriachne mucronata*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 70%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adsurgens	+	1.8 m	BC44.01	
Acacia monticola	3%	2.8 m	BC56.02	
Acacia orthocarpa	+	0.5 m	BC37.02	
Acacia retivenea subsp. *clandestina*	1%	1.2 m	BC56.04	
Acacia tumida var. *pilbarensis*	1%	1.5 m	BC56.01	
Amaranthus sp.	(+)	0.2 m	NC	Dead
Corchorus parviflorus	1%	0.8 m	BC56.10	
Cymbopogon ambiguus	1%	1 m	NC	
Cyperus hesperius	+	0.3 m	BC56.14	
Eriachne mucronata	1%	0.3 m	BC44.02	
Eucalyptus leucophloia subsp. *leucophloia*	1%	3.5 m	NC	
Grevillea wickhamii subsp. *hispidula*	1%	2.5 m	BC56.06	
Petalostylis cassioides	+	0.5 m	BC44.04	
Senna glutinosa subsp. *glutinosa*	+	1.5 m	NC	
Sida fibulifera	+	0.3 m	BC44.03	
Triodia epactia	20%	0.5 m	BC56.03	

Beaton's Creek Nullagine Novo Resources **Site** BC46

Described by BW **Date** 4/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198915 mE 7577408 mN

Habitat Hill spur / crest

Soil Red brown loam with cobbles and pebbles

Rock Type ? Granite and quartz

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over open hummock grassland of *Triodia brizoides*.

Veg Condition Good

Fire Age Old

Notes Bare ground: 90%
Litter cover: - % Logs; + % Twigs; 2% Leaves
Disturbance: Low impact drilling nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	+	0.4 m	BC02.01
Acacia monticola	Assoc.	1-2 m	BC46.02
Acacia pyrifolia var. *pyrifolia*	+	0.4 m	NC
Dodonaea coriacea	Assoc.	0.5 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	1%	2-3 m	NC
Gompholobium oreophilum	Assoc.	0.6 m	BC02.06
Goodenia stobbsiana	Assoc.	0.2 m	NC
Senna glaucifolia	+	0.8 m	BC02.02
Triodia brizoides	12%	0.4 m	BC49.01
Triodia epactia	+	0.4 m	BC46.01

Beaton's Creek Nullagine Novo Resources   Site BC47

Described by HA   **Date** 4/09/2014 **Type** Q   100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198624 mE 7577444 mN
Habitat Open gully
Soil Thin skeletal soil

Vegetation Scattered tall shrubs of *Acacia monticola* over open hummock grassland of *Triodia epactia* over scattered tussock grasses of *Cymbopogon ambiguus*.

Veg Condition Excellent
Fire Age Moderate
Notes Bare ground: 85%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	1%	2.5 m	BC56.02
Acacia pyrifolia var. *pyrifolia*	+	1.5 m	NC
Bulbostylis barbata	+	0.1 m	BC47.01
Corchorus parviflorus	+	1 m	BC56.10
Cymbopogon ambiguus	1%	1.2 m	NC
Cyperus hesperius	+	0.4 m	BC56.14
Eriachne mucronata	+	0.4 m	BC56.05
Grevillea wickhamii subsp. *hispidula*	+	2.5 m	BC56.06
Ptilotus fusiformis	+	0.3 m	NC
Senna glutinosa subsp. *glutinosa*	+	1.5 m	NC
Triodia epactia	15%	0.5 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC48

Described by BW **Date** 4/09/2014 **Type** Q 120 x 10 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199126 mE 7577521 mN

Habitat Gully

Soil Pale brown sand

Vegetation Open shrubland of *Acacia adsurgens* and *Acacia tumida* var. *pilbarensis* over scattered low shrubs of *Acacia hilliana* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 65%
Litter cover: + % Logs; 2% Twigs; 5% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia adsurgens	3%	1-3 m	BC48.01
Acacia hilliana	1%	0.4 m	BC02.01
Acacia monticola	+	1-2 m	BC02.04
Acacia pyrifolia var. *pyrifolia*	+	1.8 m	NC
Acacia spondylophylla	+	0.4 m	BC02.03
Acacia trachycarpa x ?*tumida*	+	1.2 m	BC48.05
Acacia tumida var. *pilbarensis*	1%	1-2 m	BC48.02
Bulbostylis barbata	+	0.05 m	BC03.05
Corchorus parviflorus	+	0.3 m	BC48.04
Cymbopogon ambiguus	+	0.5 m	NC
Cyperus hesperius	+	0.3 m	BCR34.02
Dodonaea coriacea	+	0.3 m	BC02.09
Eriachne mucronata	Assoc.	0.3 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	+	4 m	NC
Gompholobium oreophilum	+	0.4 m	BC02.06
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Pluchea dentex	+	0.4 m	BC48.03
Triodia epactia	20%	0.4 m	BC48.06

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ENVIRONMENTAL MANAGEMENT & OUTCOMES FOR MINING & DEVELOPMENT

Beaton's Creek Nullagine Novo Resources **Site** BC49

Described by BW **Date** 4/09/2014 **Type** Q 80 x 30 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198890 mE 7577745 mN
Habitat Hill top
Soil Red brown loam with cobbles and pebbles
Rock Type ? Granite and quartz

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good
Fire Age Old
Notes Bare ground: 80%
Litter cover: + % Logs; + % Twigs; 1% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia hilliana	+	0.4 m	NC
Acacia pyrifolia var. *pyrifolia*	+	1-2 m	NC
Acacia retivenea subsp. *clandestina*	+	0.6 m	BC49.02
Acacia spondylophylla	Assoc.	0.4 m	BC02.03
Corchorus parviflorus	+	0.4 m	BC49.04
Corymbia deserticola subsp. *deserticola*	Assoc.	1.6 m	BC35.07
Dampiera candicans	+	0.4 m	NC
Dodonaea coriacea	+	0.6 m	BC49.05
Eucalyptus leucophloia subsp. *leucophloia*	4%	2-4 m	NC
Gompholobium oreophilum	Assoc.	0.6 m	BC02.06
Goodenia stobbsiana	+	0.2 m	NC
Ptilotus calostachyus	+	1.2 m	BC49.03
Senna glaucifolia	+	0.6 m	BC02.02
Senna glutinosa subsp. *glutinosa*	+	1.2 m	NC
Triodia brizoides	20%	0.4 m	BC49.01

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Beaton's Creek Nullagine Novo Resources **Site** BC50

Described by HA **Date** 4/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198780 mE 7577359 mN

Habitat Upper gully

Soil Skeletal soil

Vegetation High open shrubland of *Acacia monticola*, *Acacia adsurgens* and *Grevillea wickhamii* subsp. *hispidula* over scattered low shrubs of *Corchorus parviflorus* over hummock grassland of *Triodia epactia*.

Veg Condition Excellent

Fire Age Moderate

Notes Bare ground: 70%
Litter cover: + % Logs; 1% Twigs; 1% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia adoxa var. *adoxa*	+	0.3 m	NC	
Acacia adsurgens	2%	2.5 m	BCR34.04	
Acacia hilliana	+	0.5 m	BC37.04	
Acacia monticola	4%	2.5 m	BC56.02	
Acacia spondylophylla	+	0.5 m	BC37.06	
Corchorus parviflorus	1%	0.8 m	BC56.10	
Dampiera candicans	+	0.3 m	NC	
Eriachne mucronata	+	0.3 m	BC56.05	
Eucalyptus leucophloia subsp. *leucophloia*	+	1.2 m	NC	Juveniles
Gompholobium oreophilum	+	0.5 m	BC56.07	
Goodenia stobbsiana	+	0.3 m	NC	
Grevillea wickhamii subsp. *hispidula*	2%	3 m	BC56.06	
Triodia epactia	32%	0.3 m	BC50.01	

Beaton's Creek Nullagine Novo Resources **Site** BC52

Described by BW **Date** 6/09/2014 **Type** Q 60 x 40 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201303 mE 7579328 mN

Habitat Dam banks

Soil Brown clayey sand

Vegetation Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high shrubland of *Melaleuca glomerata* over very open hummock grassland of *Triodia epactia*.

Veg Condition Good

Fire Age Very Old

Notes Bare ground: 90%
Litter cover: 1% Logs; 5% Twigs; 8% Leaves
Disturbance: ? Salinity - ? salt crusting on solid surface

SPECIES LIST:

	Cover	Height	Specimen
Bergia pedicellaris	+	0.05 m	BC52.02
Centipeda minima subsp. *macrocephala*	+	0.05 m	BC52.04
Chrysocephalum apiculatum	+	0.05 m	BC52.03
Eucalyptus camaldulensis subsp. *refulgens*	5%	5-10 m	BC52.07
Goodenia lamprosperma	+	0.4 m	BC52.01
Melaleuca glomerata	15%	2-3 m	BC52.06
Potamogeton tricarinatus	+	-	BC52.05
Triodia epactia	8%	0.5 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BC53

Described by HA **Date** 6/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201439 mE 7579458 mN
Habitat River bed
Soil Brown sand with river stones

Vegetation Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over open shrubland of *Melaleuca glomerata* over very open hummock grassland of *Triodia epactia*.

Veg Condition Poor
Fire Age Old
Notes Bare ground: 90%
Litter cover: 1% Logs; 2% Twigs; 2% Leaves
Disturbance:

SPECIES LIST:

	Cover	Height	Specimen
Acacia tumida var. *pilbarensis*	+	2.1 m	BC56.01
Ammannia auriculata	+	0.1 m	BC53.06
Ammannia baccifera	+	0.1 m	BC53.02
Calandrinia quadrivalvis	+	0.02 m	HA49
Centipeda minima subsp. *minima*	+	0.1 m	BC53.04
Chrysocephalum apiculatum	+	0.1 m	BC52.03
Corchorus parviflorus	+	0.9 m	BC56.10
Cyperus ixiocarpus	+	0.5 m	HA28b
Eucalyptus camaldulensis subsp. *refulgens*	8%	6-10 m	BC52.07
Gonocarpus ephemerus	+	0.3 m	BC53.05
Goodenia lamprosperma	+	0.2 m	BC52.01
Melaleuca glomerata	4%	2 m	BC52.06
Pluchea dentex	+	0.3 m	HA18
Schenkia clementii	+	0.1 m	BC53.03
Stemodia viscosa	+	0.3 m	HA30
Triodia epactia	5%	0.5 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC54

Described by HA **Date** 7/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201530 mE 7578856 mN

Habitat Dam bank

Soil Brown loam with salt crust

Vegetation Low open woodland of *Eucalyptus camaldulensis* subsp. *refulgens* over high open shrubland of *Melaleuca glomerata* and *Melaleuca argentea* over very open herbland of *Goodenia lamprosperma*, *Pluchea rubelliflora*, *Chrysocephalum apiculatum* and *Centipeda minima* subsp. *macrocephala*.

Veg Condition Poor

Fire Age Very Old

Notes Bare ground: 90%
Litter cover: + % Logs; 1% Twigs; 4% Leaves
Disturbance: Dam area is man made. Salt crusting on soil surface.

SPECIES LIST:

	Cover	Height	Specimen
Acacia coriacea subsp. *pendens*	+	2.5 m	BC54.04
Alternanthera nana	+	0.1 m	BC54.07
Ammannia baccifera	+	0.1 m	BC53.02
Centipeda minima subsp. *macrocephala*	0.5%	0.05 m	BC52.04
Chrysocephalum apiculatum	0.5%	0.05 m	BC52.03
Dysphania plantaginella	+	0.05 m	BC54.06
Eucalyptus camaldulensis subsp. *refulgens*	6%	9 m	BC52.07
Goodenia lamprosperma	1%	0.2 m	BC52.01
Heliotropium chrysocarpum	+	0.1 m	BC54.03
Melaleuca argentea	1%	3 m	BC54.05
Melaleuca glomerata	3%	3 m	BC52.06
Pluchea rubelliflora	0.5%	0.2 m	BC54.02
Schenkia clementii	+	0.1 m	BC53.03
Trianthema glossostigma	+	Prostrate	BC54.01

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Beaton's Creek Nullagine Novo Resources **Site** BC55

Described by BW **Date** 7/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201728 mE 7579193 mN

Habitat Hill crest

Soil Red brown silty loam with cobbles and pebbles

Vegetation Scattered low shrubs of *Acacia spondylophylla* over open hummock grassland of *Triodia brizoides*

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: - % Logs; +% Twigs; +% Leaves
Disturbance: Track nearby
Notes: Patchy fire scar in the area

SPECIES LIST:

	Cover	Height	Specimen
Acacia bivenosa	+	0.6 m	NC
Acacia pyrifolia var. pyrifolia	+	1.2 m	NC
Acacia spondylophylla	1%	0.5 m	BC02.03
Eucalyptus leucophloia subsp. leucophloia	+	1 m	NC
Grevillea wickhamii subsp. hispidula	+	1 m	NC
Pluchea ferdinandi-muelleri	+	0.4 m	BC55.01
Pluchea tetranthera	+	0.4 m	BC55.02
Senna glaucifolia	+	1.5 m	BC02.02
Triodia brizoides	20%	0.4 m	BC02.08

Beaton's Creek Nullagine Novo Resources **Site** BC56

Described by HA **Date** 3/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198804 mE 7579267 mN

Habitat Rocky creek line

Soil Light brown coarse sand

Vegetation High shrubland of *Acacia monticola*, *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia epactia* over scattered tussock grasses of *Eriachne mucronata*.

Veg Condition Excellent

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: 1% Logs; 2% Twigs; 1% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	5%	1.5-2.5 m	BC56.02
Acacia pyrifolia var. *pyrifolia*	+	1 m	BC56.11
Acacia retivenea subsp. *clandestina*	+	1.2 m	BC56.04
Acacia tumida var. *pilbarensis*	5%	1.5-2.5 m	BC56.01
Bulbostylis barbata	+	0.1 m	BC56.12
Clerodendrum tomentosum var. *lanceolatum*	+	2.5 m	BC56.09
Corchorus parviflorus	+	0.8 m	BC56.10
Cymbopogon ambiguus	+	1 m	NC
Cyperus hesperius	+	0.4 m	BC56.14
Eriachne mucronata	1%	0.5 m	BC56.05
Gompholobium oreophilum	+	0.8 m	BC56.07
Grevillea wickhamii subsp. *hispidula*	1%	2.5 m	BC56.06
Petalostylis labicheoides	+	2.5 m	BC56.08
Senna glutinosa subsp. *glutinosa*	+	1.5 m	NC
Tribulus suberosus	+	1.2 m	BC56.13
Triodia epactia	15%	0.5 m	BC56.03

Beaton's Creek Nullagine Novo Resources **Site** BC57

Described by BW **Date** 5/09/2014 **Type** Q 120 x 10 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198885 mE 7577978 mN

Habitat Creek line

Soil Pale brown sand with creek stones

Vegetation Scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Eucalyptus victrix* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* over scattered sedges of *Cyperus ixiocarpus* over scattered tussock grasses of *Eriachne mucronata*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 90%
Litter cover: + % Logs; 1% Twigs; 3% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.3 m	BC02.05
Acacia adsurgens	+	1.2 m	BC48.01
Acacia dictyophleba	+	0.7 m	BC57.02
Acacia monticola	+	1 m	BC02.04
Acacia orthocarpa	+	0.6 m	BC06.06
Acacia pyrifolia var. *pyrifolia*	Assoc.	1.2 m	NC
Acacia spondylophylla	+	0.4 m	BC02.03
Acacia tumida var. *pilbarensis*	5%	1-2 m	NC
Calandrinia quadrivalvis	Assoc.	0.05 m	HA49
Cymbopogon ambiguus	Assoc.	0.6 m	NC
Cyperus ixiocarpus	1%	0.6 m	BC57.04
Eriachne benthamii	+	0.4 m	BC57.03
Eriachne mucronata	1%	0.4 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	1%	3-6 m	NC
Eucalyptus victrix	+	3-8 m	BC57.07
Euphorbia australis var. *subtomentosa*	+	0.1 m	BC05.02
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Indigofera monophylla	+	1 m	NC
Melaleuca glomerata	+	1-2 m	BC57.01
Pluchea dentex	+	0.4 m	BC48.03
Ptilotus fusiformis	+	0.3 m	NC
Sida echinocarpa	Assoc.	0.5 m	BC57.06
Tribulus suberosus	Assoc.	0.4 m	BC57.05
Triodia epactia	8%	0.6 m	BC02.07

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Beaton's Creek Nullagine Novo Resources   Site BC58

Described by BW   **Date** 4/09/2014 **Type** Q   50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51   199482 mE   7577970 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia spondylophylla* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: + % Logs; + % Twigs; 1% Leaves
Disturbance: Drill pads and tracks nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	+	0.4 m	BC02.01
Acacia pyrifolia var. *pyrifolia*	+	0.8 m	NC
Acacia spondylophylla	2%	0.3 m	BC02.03
Acacia tumida var. *pilbarensis*	+	0.8 m	BC06.01
Bonamia media	+	0.05 m	NC
Dampiera candicans	+	0.6 m	NC
Dodonaea coriacea	+	0.6 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	2%	3-5 m	NC
Goodenia cusackiana	+	0.2 m	NC
Goodenia stobbsiana	+	0.2 m	NC
Senna glaucifolia	+	0.8 m	BC02.02
Tephrosia supina	+	0.3 m	BC03.06
Triodia brizoides	20%	0.3 m	BC49.01
Triodia epactia	+	0.3 m	BC46.01

Beaton's Creek Nullagine Novo Resources **Site** BC59

Described by BW **Date** 5/09/2014 **Type** Q 80 x 30 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198534 mE 7578047 mN

Habitat Wide rock channel gully

Soil Red brown sandy loam with angular and rounded rocks

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over closed scrub of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over scattered shrubs of *Indigofera monophylla* over scattered low shrubs of *Acacia spondylophylla* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 10%
Litter cover: 3% Logs; 5% Twigs; 70% Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia monticola	+	1.2 m	BC02.04
Acacia orthocarpa	+	0.5 m	BC06.06
Acacia pyrifolia var. *pyrifolia*	+	1-2 m	NC
Acacia spondylophylla	1%	0.4 m	BC02.03
Acacia tumida var. *pilbarensis*	70%	2-3 m	NC
Corymbia hamersleyana	1%	2-5 m	NC
Dampiera candicans	+	0.4 m	NC
Eriachne mucronata	+	0.4 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	2%	2-5 m	NC
Gompholobium oreophilum	+	0.5 m	BC02.06
Goodenia triodiophila	+	0.4 m	NC
Grevillea wickhamii subsp. *hispidula*	6%	2-4 m	NC
Indigofera monophylla	1%	1-1.5 m	NC
Petalostylis cassioides	+	0.5 m	BC59.02
Pluchea dentex	+	0.4 m	BC48.03
Santalum lanceolatum	+	2-3 m	BC59.03
Senna glutinosa subsp. *glutinosa*	+	0.8 m	NC
Sida arenicola	+	1.5 m	BC59.04
Stemodia viscosa	+	0.8 m	HA30
Triodia epactia	15%	0.5 m	BC59.01

Beaton's Creek Nullagine Novo Resources **Site** BC61

Described by HA **Date** 4/09/2014 **Type** Q 100 x 25 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 198771 mE 7577528 mN

Habitat Hill top / ridge

Soil Shallow red brown loam

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Acacia spondylophylla* and *Acacia hilliana* over hummock grassland of *Triodia brizoides*.

Veg Condition Excellent

Fire Age Old

Notes Bare ground: 65%
Litter cover: + % Logs; + % Twigs; + % Leaves
Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.3 m	NC
Acacia hilliana	1%	0.4 m	BC37.04
Acacia pyrifolia var. *pyrifolia*	+	1.2 m	NC
Acacia spondylophylla	6%	0.5 m	BC37.06
Bonamia media	+	0.1 m	BC61.05
Dodonaea coriacea	+	0.5 m	BC37.03
Eriachne lanata	+	0.3 m	BC61.03
Eucalyptus leucophloia subsp. *leucophloia*	1.5%	3 m	NC
Goodenia stobbsiana	+	0.2 m	NC
Grevillea pyramidalis subsp. *leucadendron*	+	2 m	BC61.02
Isotropis atropurpurea	+	0.3 m	BC61.04
Ptilotus calostachyus	+	0.3 m	NC
Senna glaucifolia	+	0.8 m	BC02.02
Senna glutinosa subsp. *glutinosa*	+	1.2 m	NC
Triodia brizoides	35%	0.4 m	BC61.01

Beaton's Creek Nullagine Novo Resources **Site** BC62

Described by HA **Date** 6/09/2014 **Type** Q 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199388 mE 7580475 mN

Habitat Low hills / crest

Soil Shallow red brown loam

Vegetation Scattered shrubs of *Grevillea wickhamii* subsp. *hispidula* over low shrubland of *Acacia orthocarpa*, *Gompholobium oreophilum* and *Acacia spondylophylla* over open hummock grassland of *Triodia epactia*.

Veg Condition Excellent

Fire Age Young

Notes Bare ground: 75%
Litter cover: - % Logs; + % Twigs; + % Leaves
Disturbance: Nil
Notes: 2 Pebble mound mouse mounds

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	+	0.3 m	BC37.04
Acacia monticola	+	1 m	BC56.02
Acacia orthocarpa	20%	0.5 m	BC37.02
Acacia spondylophylla	1%	0.3 m	BC37.06
Bonamia media	+	0.05 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	+	1.8 m	NC
Gompholobium oreophilum	2%	0.5 m	BC56.07
Goodenia stobbsiana	+	0.2 m	NC
Grevillea wickhamii subsp. *hispidula*	1%	1.5 m	BC56.06
Triodia epactia	20%	0.3 m	BC56.03

Beaton's Creek Nullagine Novo Resources   **Site** BCR17

Described by BW   **Date** 4/09/2014 **Type** R   ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199198 mE 7579302 mN

Habitat Steep gully

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over open shrubland of *Acacia monticola* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Young

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	7%	1-2 m	NC
Acacia retivenea subsp. *clandestina*	+	1-2 m	BC49.02
Eucalyptus leucophloia subsp. *leucophloia*	+	2 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Triodia epactia	12%	0.4 m	BC46.01

Beaton's Creek Nullagine Novo Resources **Site** BCR19

Described by BW **Date** 5/09/2014 **Type** R ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200225 mE 7579163 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered shrubs of *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 85%
Litter cover: - % Logs; + % Twigs; + % Leaves
Disturbance: Drill track and drill pads nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.2 m	BC02.05
Acacia hilliana	+	0.3 m	BC02.01
Acacia pyrifolia var. *pyrifolia*	+	1-2 m	NC
Acacia spondylophylla	+	0.3 m	BC02.03
Acacia tumida var. *pilbarensis*	+	0.6 m	NC
Calytrix carinata	+	0.4 m	BCR19.01
Corymbia deserticola subsp. *deserticola*	+	2-3 m	BC35.07
Corymbia hamersleyana	+	3 m	NC
Dodonaea coriacea	+	0.3 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	+	2-3 m	NC
Gompholobium oreophilum	+	0.4 m	BC02.06
Goodenia stobbsiana	+	0.4 m	NC
Goodenia triodiophila	+	0.2 m	NC
Grevillea wickhamii subsp. *hispidula*	+	1-2 m	NC
Ptilotus calostachyus	+	0.5 m	NC
Triodia brizoides	15%	0.4 m	BC02.08

Beaton's Creek Nullagine Novo Resources **Site** BCR22

Described by BW **Date** 4/09/2014 **Type** R ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199133 mE 7578490 mN

Habitat Low hills

Soil Red brown loam

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered low shrubs of *Acacia orthocarpa* over open hummock grassland of *Triodia brizoides* and *Triodia epactia*.

Veg Condition Very Good

Fire Age Moderate

Notes Bare ground: 80%
Litter cover: + % Logs; 1% Twigs; 2% Leaves
Disturbance: Vehicle tracks nearby
Notes: Low gullies dissecting throughout the low hills

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	+	1-2 m	BC02.04
Acacia orthocarpa	1%	0.5 m	BC06.06
Acacia pyrifolia var. *pyrifolia*	+	2 m	NC
Corymbia hamersleyana	+	2-4 m	NC
Eucalyptus leucophloia subsp. *leucophloia*	1%	2-5 m	NC
Gompholobium oreophilum	+	0.6 m	BC02.06
Grevillea wickhamii subsp. *hispidula*	+	2 m	NC
Senna glaucifolia	+	0.5 m	BC02.02
Triodia brizoides	7%	0.3 m	BC49.01
Triodia epactia	7%	0.6 m	BC46.01

Beaton's Creek Nullagine Novo Resources **Site** BCR24

Described by BW **Date** 5/09/2014 **Type** R ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 200855 mE 7578764 mN

Habitat Gully between steep hills

Soil Pale brown sand with creek stones

Vegetation Open shrubland of *Acacia tumida* var. *pilbarensis*, *Acacia monticola* and *Grevillea wickhamii* subsp. *hispidula* over open hummock grassland of *Triodia epactia*.

Veg Condition Very Good

Fire Age Old

Notes Disturbance: Nil

SPECIES LIST:

	Cover	Height	Specimen
Acacia monticola	1%	1-2 m	NC
Acacia pyrifolia var. *pyrifolia*	+	1-2 m	NC
Acacia tumida var. *pilbarensis*	3%	1-2 m	NC
Eriachne mucronata	+	0.4 m	NC
Grevillea wickhamii subsp. *hispidula*	1%	1-2 m	NC
Triodia epactia	15%	0.6 m	BC02.07

Beaton's Creek Nullagine Novo Resources   Site   BCR25

Described by BW   **Date** 5/09/2014 **Type** R   ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51   199949 mE   7579044 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over scattered low shrubs of *Acacia hilliana* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Old

Notes Bare ground: 80%
Litter cover: + % Logs; + % Twigs; 1% Leaves
Disturbance: Drill track and drill pads nearby

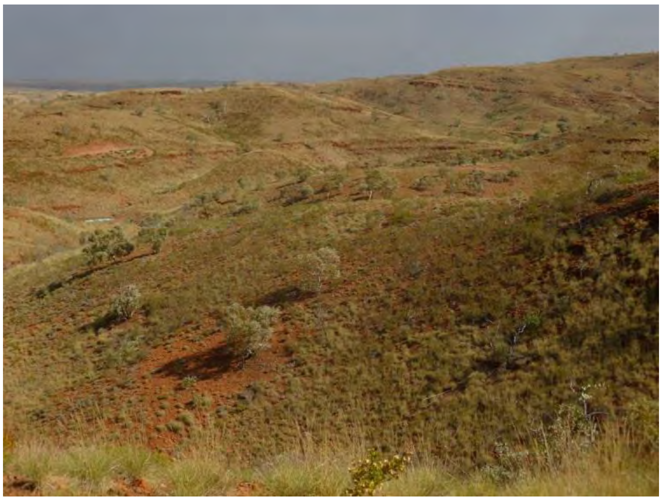
SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.4 m	BC02.05
Acacia hilliana	+	0.4 m	BC02.01
Eucalyptus leucophloia subsp. *leucophloia*	1%	2-4 m	NC
Gompholobium oreophilum	+	0.4 m	BC02.06
Goodenia cusackiana	+	0.1 m	HA26
Goodenia triodiophila	+	0.2 m	NC
Senna glaucifolia	+	0.6 m	BC02.02
Triodia brizoides	20%	0.4 m	BC02.08
Triodia epactia	+	0.3 m	BC02.07

Beaton's Creek Nullagine Novo Resources **Site** BCR27

Described by BW **Date** 4/09/2014 **Type** R ~ 50 x 50

Location 1 km north-west of Nullagine, Western Australia



MGA Zone 51 199565 mE 7578445 mN

Habitat Hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Low open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over low open shrubland of *Gompholobium oreophilum* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Young

Notes Bare ground: 85%
Litter cover: + % Logs; + % Twigs; 2% Leaves
Disturbance: Track nearby

SPECIES LIST:

	Cover	Height	Specimen
Acacia hilliana	+	0.3 m	NC
Acacia pyrifolia var. *pyrifolia*	+	1.3 m	NC
Acacia spondylophylla	+	0.4 m	BC02.03
Corymbia hamersleyana	+	2-3 m	NC
Dodonaea coriacea	+	0.4 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	2%	2-5 m	NC
Gompholobium oreophilum	4%	0.6 m	BC02.06
Goodenia cusackiana	+	0.3 m	NC
Senna glutinosa subsp. *glutinosa*	+	0.6 m	NC
Triodia brizoides	15%	0.3 m	BC49.01

Beaton's Creek Nullagine Novo Resources   Site BCR29

Described by BW   **Date** 6/09/2014 **Type** R   ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 201335 mE 7578449 mN

Habitat ? Rehabilitation area

Soil Pale brown sand, gravel, clay pan nearby

Vegetation Scattered low trees of *Eucalyptus camaldulensis* subsp. *refulgens* over open shrubland of *Petalostylis labicheoides* and *Acacia tumida* var. *pilbarensis* over scattered low shrubs of *Acacia trachycarpa* over very open hummock grassland of *Triodia longiceps*.

Veg Condition Very Poor

Fire Age Not burnt since growth

Notes Bare ground: 90%
Litter cover: - % Logs; + % Twigs; + % Leaves
Disturbance: ? Weeds, regrowth
Notes: Rehabilitation / regrowth of a disturbed area with un-natural covers of shrub species

SPECIES LIST:

	Cover	Height	Specimen
Acacia synchronicia	+	0.5 m	NC
Acacia trachycarpa	1%	0.6 m	NC
Acacia tumida var. *pilbarensis*	1%	1-2 m	NC
**Calotropis procera*	+	1-2 m	BW05
Cymbopogon ambiguus	+	0.8 m	NC
Eucalyptus camaldulensis subsp. *refulgens*	1%	4-8 m	NC
Indigofera monophylla	+	1-2 m	NC
Petalostylis labicheoides	7%	1-2 m	NC
Triodia longiceps	4%	0.5 m	NC

Beaton's Creek Nullagine Novo Resources **Site** BCR34

Described by BW **Date** 3/09/2014 **Type** R ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199526 mE 7577346 mN

Habitat Open gorge / gully

Soil Red brown loam and sand

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over very open tussock grassland of *Cymbopogon ambiguus*.

Veg Condition Very Good

Fire Age Very Old

Notes Bare ground: 70%
Litter cover: + % Logs; 4% Twigs; 4% Leaves
Disturbance: Drill pad nearby (~ 200 m away)

SPECIES LIST:

	Cover	Height	Specimen	Notes
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	+	0.2 m	HA19	
Acacia adsurgens	+	2-5 m	BCR34.04	
Acacia monticola	+	2-3 m	NC	
Acacia orthocarpa	+	0.7 m	NC	
Acacia pyrifolia var. *pyrifolia*	+	2-3 m	NC	
Atalaya hemiglauca	+	2-4 m	HA16	
Cenchrus ciliaris	+	0.4 m	NC	
Cheilanthes brownii	+	0.1 m	HA24a	
Cucumis variabilis	+	climber	BCR34.01	
Cymbopogon ambiguus	2%	0.6 m	NC	
Cyperus hesperius	+	0.4 m	BCR34.02	
Ehretia saligna var. *saligna*	+	1-3 m	BCR34.03	
Eriachne mucronata	+	0.3 m	NC	
Eucalyptus leucophloia subsp. *leucophloia*	1%	4-6 m	NC	
Euphorbia careyi	+	0.2 m	HA15	
Lepidium pedicellosum	+	0.3 m	HA21	
Nicotiana benthamiana	+	0.1 m	HA23a	
Pluchea dentex	+	0.2 m	HA18	
Rhodanthe margarethae	+	0.1 m	HA22	
Senna glutinosa subsp. *glutinosa*	+	1-2 m	NC	
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	+	0.4 m	HA17	Ferruginous form
Solanum ? horridum	+	0.3 m	BCR34.05	
Tinospora smilacina	+	0.4 m	HA14	

Beaton's Creek Nullagine Novo Resources   Site   BCR35

Described by BW   **Date** 3/09/2014 **Type** R   ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51   199832 mE   7577620 mN

Habitat Intersecting gullies between hills

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Ficus brachypoda* over open shrubland of *Acacia tumida* var. *pilbarensis* over very open hummock grassland of *Triodia epactia* and *Triodia brizoides*.

Veg Condition Poor

Fire Age Old

Notes Bare ground: 80%

Litter cover: + % Logs; 3% Twigs; 6% Leaves

Disturbance: Recent drilling tracks and pads on hills and in gullies, drill samples in bags

Notes: Several horizontal mine shafts into the hillside

SPECIES LIST:

	Cover	Height	Specimen	Notes
Acacia acradenia	+	1.2 m	BCR35.05	
Acacia adoxa var. *adoxa*	+	0.2 m	BC02.05	
Acacia pyrifolia var. *pyrifolia*	+	1.6 m	NC	
Acacia tumida var. *pilbarensis*	5%	1-2 m	BC06.01	
Bonamia media	+	0.2 m	BCR35.03	
Corymbia deserticola subsp. *deserticola*	+	2-3 m	BCR35.07	
Cymbopogon ambiguus	+	0.6 m	NC	
Dodonaea coriacea	+	0.4 m	BC02.09	
Eriachne mucronata	+	0.2 m	NC	
Eucalyptus leucophloia subsp. *leucophloia*	1%	3-5 m	NC	
Ficus brachypoda	1%	6-7 m	BCR35.06	
Gompholobium oreophilum	+	0.4 m	BC02.06	
Goodenia stobbsiana	+	0.3 m	BCR35.01	
Grevillea wickhamii subsp. *hispidula*	+	1.4 m	NC	
Senna glaucifolia	+	0.8 m	BC02.02	
Sida arenicola	+	0.8 m	BCR35.04	
Solanum sp.	+	0.2 m	NC	Dead
Triodia brizoides	3%	0.3 m	BCR35.02	
Triodia epactia	4%	0.4 m	BC06.03	

Beaton's Creek Nullagine Novo Resources **Site** BCR60

Described by BW **Date** 5/09/2014 **Type** R ~ 50 x 50 m

Location 1 km north-west of Nullagine, Western Australia

MGA Zone 51 199545 mE 7579336 mN

Habitat Hill crest / hill slope

Soil Red brown loam with cobbles and pebbles

Vegetation Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over open hummock grassland of *Triodia brizoides*.

Veg Condition Very Good

Fire Age Young

Notes Bare ground: 90%
Litter cover: - % Logs; + % Twigs; + % Leaves
Disturbance: Drill track and drill pads nearby
Notes: Relatively recent patchy burn scar

SPECIES LIST:

	Cover	Height	Specimen
Acacia adoxa var. *adoxa*	+	0.3 m	BC02.05
Acacia hilliana	+	0.2 m	BC02.01
Acacia maitlandii	+	0.4 m	NC
Acacia pyrifolia var. *pyrifolia*	+	1 m	NC
Acacia spondylophylla	+	0.3 m	BC02.03
Corymbia hamersleyana	+	1 m	NC
Dampiera candicans	+	0.3 m	NC
Dodonaea coriacea	+	0.5 m	BC02.09
Eucalyptus leucophloia subsp. *leucophloia*	+	2-4 m	NC
Gompholobium oreophilum	+	0.4 m	BC02.06
Goodenia stobbsiana	+	0.2 m	NC
Goodenia triodiophila	+	0.2 m	NC
Hakea lorea subsp. *lorea*	+	1.5 m	NC
Ptilotus calostachyus	+	0.5 m	NC
Senna glaucifolia	+	0.4 m	BC02.02
Triodia brizoides	12%	0.4 m	BC02.08
Triodia epactia	+	0.3 m	BC02.07

Beaton's Creek Nullagine Novo Resources — Opportunistic Collections

Location 1 km north-west of Nullagine, Western Australia

SPECIES LIST:

	Specimen	
Acacia aphanoclada x *pyrifolia* var. *pyrifolia*	NC	
Acacia synchronicia (broad phyllode variant)	BW03	
Calotropis procera	BW05	
Cymbopogon ambiguus	BW02	
Melaleuca eleuterostachya	BW04	
Swainsona stenodonta	BW05	
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	HA19	
Acacia acradenia	HA54	
Acacia acradenia	HA13	
Acacia adsurgens	HA03	
Acacia adsurgens	HA20	
Acacia ancistrocarpa	NC	
Acacia cyperophylla var. *omearana*	HA42	WP 16
Acacia cyperophylla var. *omearana*	HA41	WP 15
Acacia dictyophleba	HA40	WP 14
Acacia maitlandii	HA33	
Acacia pruinocarpa	NC	
Acacia stellaticeps	HA65	
Acacia synchronicia	HA77	
Acacia trachycarpa	HA55	
Acacia trachycarpa x ?*monticola*	HA01	
Acacia trachycarpa x ?*tumida*	HA72	
Aerva javanica	NC	
Ammannia baccifera	HA35	
Aristida contorta	NC	
Aristida contorta	HA83	
Aristida holathera var. *holathera*	NC	
Atalaya hemiglauca	HA16	
Atriplex codonocarpa	HA82	
Bonamia erecta	HA64	
Bonamia media	HA05	
Calandrinia quadrivalvis	HA49	
Capparis spinosa var. *nummularia*	HA69	
Cassytha capillaris	HA24b	
Cenchrus ciliaris	NC	
Cheilanthes brownii	HA24a	
Cleome viscosa	NC	
Clerodendrum floribundum var. *angustifolium*	HA51	
Corchorus parviflorus	HA85	
Corchorus walcottii	HA27	
Cucumis variabilis	HA46	
Cullen lachnostachys	HA70	
Cynanchum floribundum	HA81	
Cyperus ixiocarpus	HA28b	
Dysphania rhadinostachya subsp. *rhadinostachya*	HA60	
Enneapogon lindleyanus	HA23b	
Eragrostis cumingii	HA45	
Eragrostis eriopoda	HA66	
Euphorbia australis var. *subtomentosa*	HA87	
Euphorbia boophthona	HA57	
Euphorbia careyi	HA15	
Evolvulus alsinoides var. *villosicalyx*	NC	
Ficus brachypoda	HA11	
Gonocarpus ephemerus	HA36	
Goodenia cusackiana	HA26	
Goodenia triodiophila	HA08	
Gossypium australe	HA32	
Grevillea berryana	HA53	
Hakea chordophylla	NC	
Hakea lorea subsp. *lorea*	NC	
Heliotropium skeleton	HA38	

Heliotropium skeleton	HA07	
Hibiscus coatesii	HA29	
Hibiscus coatesii	HA43	WP 17
Hibiscus sturtii var. *campylochlamys*	HA50	
Indigofera monophylla	HA10	
Lepidium pedicellosum	HA21	
Maireana carnosa	HA76	
Maireana melanocoma	HA73	
Maireana tomentosa subsp. *tomentosa*	HA09	
Maireana tomentosa subsp. *tomentosa*	HA71	
Mollugo molluginea	NC	
Nicotiana benthamiana	HA23a	
Petalostylis cassioides	HA12	
Petalostylis labicheoides	HA84	
Pluchea dentex	HA18	
Pluchea tetranthera	HA52	
Polycarpaea holtzei	HA06	
Pterocaulon sphaeranthoides	HA56	
Ptilotus astrolasius	NC	
Ptilotus axillaris	HA62	
Ptilotus incanus	HA61	
Ptilotus incanus	HA25	
Ptilotus incanus	HA78	
Ptilotus nobilis subsp. *nobilis*	NC	
Ptilotus wilsonii	HA75	
Ptilotus wilsonii	HA37	
Rhodanthe margarethae	HA22	
Salsola australis	NC	
Santalum lanceolatum	NC	
Sclerolaena eriacantha	HA74	
Senna glaucifolia	HA02	
Senna glutinosa subsp. *pruinosa*	NC	
Senna notabilis	HA34	
Sida arenicola	HA47	
Sida echinocarpa	HA79	
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	HA17	Ferruginous form
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	HA04	
Solanum phlomoides	HA39	
Solanum sturtianum	HA80	
Sporobolus australasicus	NC	
Stemodia grossa	HA31	
Stemodia viscosa	HA30	
Streptoglossa decurrens	HA86	
Streptoglossa decurrens	HA58	
Swainsona stenodonta	HA67	
Synaptantha tillaeacea var. *tillaeacea*	HA44	WP 18
Tinospora smilacina	HA14	
Trachymene oleracea subsp. *oleracea*	HA28a	
Trianthema glossostigma	HA48	
Tribulus suberosus	HA68	

APPENDIX G

FLORA TAXA INVENTORY

Family	Species	Conservation Status
Aizoaceae	*Trianthema glossostigma*	
Amaranthaceae	**Aerva javanica*	
	Alternanthera nana	
	Amaranthus sp.	
	Ptilotus astrolasius	
	Ptilotus axillaris	
	Ptilotus calostachyus	
	Ptilotus fusiformis	
	Ptilotus incanus	
	Ptilotus nobilis subsp. *nobilis*	
	Ptilotus wilsonii	Priority 1
Apocynaceae	**Calotropis procera*	
	Cynanchum floribundum	
Araliaceae	*Trachymene oleracea* subsp. *oleracea*	
Asteraceae	*Calocephalus beardii*	
	Centipeda minima subsp. *macrocephala*	
	Centipeda minima subsp. *minima*	
	Chrysocephalum apiculatum	
	Pluchea dentex	
	Pluchea ferdinandi-muelleri	
	Pluchea rubelliflora	
	Pluchea tetranthera	
	Podolepis capillaris	
	Pterocaulon sphaeranthoides	
	Rhodanthe margarethae	
	Streptoglossa decurrens	
Boraginaceae	*Ehretia saligna* var. *saligna*	
	Heliotropium chrysocarpum	
	Heliotropium skeleton	
	Trichodesma zeylanicum var. *zeylanicum*	
Brassicaceae	*Lepidium pedicellosum*	
Capparaceae	*Capparis spinosa* var. *nummularia*	
	Capparis umbonata	

Family	Species	Conservation Status
Caryophyllaceae	*Polycarpaea holtzei*	
Chenopodiaceae	*Atriplex codonocarpa*	
	Dysphania plantaginella	
	Dysphania rhadinostachya subsp. *rhadinostachya*	
	Maireana carnosa	
	Maireana melanocoma	
	Maireana tomentosa subsp. *tomentosa*	
	Salsola australis	
	Sclerolaena eriacantha	
Cleomaceae	*Cleome viscosa*	
Convolvulaceae	*Bonamia erecta*	
	Bonamia media	
	Bonamia rosea	
	Evolvulus alsinoides var. *villosicalyx*	
Cucurbitaceae	*Cucumis variabilis*	
Cyperaceae	*Bulbostylis barbata*	
	Cyperus hesperius	
	Cyperus ixiocarpus	
Elatinaceae	*Bergia pedicellaris*	
Euphorbiaceae	*Euphorbia australis* var. *subtomentosa*	
	Euphorbia boophthona	
	Euphorbia careyi	
Fabaceae	*Acacia acradenia*	
	Acacia adoxa var. *adoxa*	
	Acacia adsurgens	
	Acacia ancistrocarpa	
	Acacia aphanoclada	Priority 1
	Acacia aphanoclada x *pyrifolia* var. *pyrifolia*	
	Acacia bivenosa	
	Acacia colei var. *colei*	
	Acacia coriacea subsp. *pendens*	
	Acacia cyperophylla var. *omearana*	Priority 1
	Acacia dictyophleba	
	Acacia hilliana	
	Acacia maitlandii	
	Acacia monticola	

Family	Species	Conservation Status
Fabaceae	*Acacia orthocarpa*	
	Acacia pruinocarpa	
	Acacia pyrifolia var. *pyrifolia*	
	Acacia retivenea subsp. *clandestina*	
	Acacia sp.	
	Acacia spondylophylla	
	Acacia stellaticeps	
	Acacia synchronicia	
	Acacia synchronicia (broad phyllode variant)	
	Acacia trachycarpa	
	Acacia trachycarpa x ? *monticola*	
	Acacia trachycarpa x ? *tumida*	
	Acacia tumida var. *pilbarensis*	
	Cullen lachnostachys	
	Gompholobium oreophilum	
	Indigofera monophylla	
	Isotropis atropurpurea	
	Petalostylis cassioides	
	Petalostylis labicheoides	
	Senna glaucifolia	
	Senna glutinosa subsp. *glutinosa*	
	Senna glutinosa subsp. *luerssenii*	
	Senna glutinosa subsp. *pruinosa*	
	Senna notabilis	
	Swainsona stenodonta	
	Tephrosia supina	
Gentianaceae	*Schenkia clementii*	
Goodeniaceae	*Dampiera candicans*	
	Goodenia cusackiana	
	Goodenia lamprosperma	
	Goodenia microptera	
	Goodenia stobbsiana	
	Goodenia triodiophila	
	Scaevola browniana subsp. *browniana*	
Haloragaceae	*Gonocarpus ephemerus*	
Haloragaceae	*Haloragis gossei* var. *gossei*	

Family	Species	Conservation Status
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*	
	Clerodendrum tomentosum var. *lanceolatum*	
Lauraceae	*Cassytha capillaris*	
Lythraceae	*Ammannia auriculata*	
	Ammannia baccifera	
Malvaceae	*Abutilon* sp. Dioicum (A.A. Mitchell PRP 1618)	
	Corchorus parviflorus	
	Corchorus walcottii	
	Gossypium australe	
	Hibiscus coatesii	
	Hibiscus sturtii var. *campylochlamys*	
	Sida arenicola	
	Sida echinocarpa	
	Sida fibulifera	
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)	
	Waltheria indica	
	Waltheria virgata	
Menispermaceae	*Tinospora smilacina*	
Molluginaceae	*Mollugo molluginea*	
Moraceae	*Ficus brachypoda*	
Myrtaceae	*Calytrix carinata*	
	Corymbia candida subsp. *dipsodes*	
	Corymbia deserticola subsp. *deserticola*	
	Corymbia hamersleyana	
	Eucalyptus camaldulensis subsp. *refulgens*	
	Eucalyptus leucophloia subsp. *leucophloia*	
	Eucalyptus victrix	
	Melaleuca argentea	
	Melaleuca eleuterostachya	
	Melaleuca glomerata	
Phyllanthaceae	? *Sauropus* sp.	
	Phyllanthus maderaspatensis	
Plantaginaceae	*Stemodia grossa*	
	Stemodia viscosa	
Poaceae	*Aristida contorta*	
	Aristida holathera var. *holathera*	

Family	Species	Conservation Status
Poaceae	**Cenchrus ciliaris*	
	Cymbopogon ambiguus	
	Enneapogon lindleyanus	
	Eragrostis cumingii	
	Eragrostis eriopoda	
	Eriachne benthamii	
	Eriachne lanata	
	Eriachne mucronata	
	Sporobolus australasicus	
	Triodia brizoides	
	Triodia epactia	
	Triodia longiceps	
Portulacaceae	*Calandrinia quadrivalvis*	
Potamogetonaceae	*Potamogeton tricarinatus*	
Proteaceae	*Grevillea berryana*	
	Grevillea pyramidalis subsp. *leucadendron*	
	Grevillea wickhamii subsp. *hispidula*	
	Hakea chordophylla	
	Hakea lorea subsp. *lorea*	
Pteridaceae	*Cheilanthes brownii*	
Rubiaceae	*Synaptantha tillaeacea* var. *tillaeacea*	
Santalaceae	*Santalum lanceolatum*	
Sapindaceae	*Atalaya hemiglauca*	
	Dodonaea coriacea	
Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*	
Solanaceae	*Nicotiana benthamiana*	
	Solanum ? horridum	
	Solanum phlomoides	
	Solanum sp.	
	Solanum sturtianum	
Violaceae	*Hybanthus aurantiacus*	
Zygophyllaceae	*Tribulus suberosus*	

APPENDIX H

MATRIX OF FLORA RECORDED WITHIN EACH QUADRAT AND RELEVÉ

Note: Any species with without data presented in the following pages were recorded opportunistically

Species	BC01	BC02	BC03	BC04	BC05	BC06	BC07	BC08	BC09	BC11	BC12	BC13	BC14	BC15	BC16	BC20	BC23	BC26	BC33	BC36	BC37	BC38	BC39	BC40	BC42
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)																									
Acacia acradenia																			Assoc.					+	
Acacia adoxa var. *adoxa*		1%	+	+			+					+	+		+			+							+
Acacia adsurgens			+																						
Acacia ancistrocarpa																									
Acacia aphanoclada							+						+												
Acacia aphanoclada x *pyrifolia* var. *pyrifolia*																									
Acacia bivenosa							2%		+					+					1%	+				+	
Acacia colei var. *colei*						Assoc.																			
Acacia coriacea subsp. *pendens*																									
Acacia cyperophylla var. *omearana*																									
Acacia dictyophleba																									
Acacia hilliana		3%	2%	+									1%					1%	+	+	8%		4%		2%
Acacia maitlandii								+	+		+	+		+		+									
Acacia monticola	Assoc.	+	+	+	+	+						+		+		0.5%		4%			+	+			
Acacia orthocarpa	+		3%	Assoc.	+	Assoc.	1%			+		+	1%	+		+				3%	1%		20%		
Acacia pruinocarpa				+																					
Acacia pyrifolia var. *pyrifolia*	+	+		+			+					+			+	+	+	+		+	+	+			+
Acacia retivenea subsp. *clandestina*				Assoc.																	+				
Acacia sp.			+																						
Acacia spondylophylla	+	2%	+	+		Assoc.	+			+		+	+	+	+	+				1%	+		1%		2%
Acacia stellaticeps																									
Acacia synchronicia																									
Acacia synchronicia (broad phyllode variant)																									
Acacia trachycarpa									1%																
Acacia trachycarpa x ? *monticola*																									
Acacia trachycarpa x ? *tumida*								+	+					+											
Acacia tumida var. *pilbarensis*	20%				1%	4%		7%	5%	20%	6%	12%		12%	20%	0.5%	+	4%	+			+			+
Aerva javanica																									
Alternanthera nana																									
Amaranthus sp.																									
Ammannia auriculata																									
Ammannia baccifera																									
Aristida contorta																									
Aristida holathera var. *holathera*									(+)																
Atalaya hemiglauca																									
Atriplex codonocarpa																									
Bergia pedicellaris																									
Bonamia erecta																									
Bonamia media							+																		+
Bonamia rosea									+																
Bulbostylis barbata			+				(+)									+	+			(+)					
Calandrinia quadrivalvis								+																	
Calocephalus beardii									+																
Calotropis procera																									
Calytrix carinata																									
Capparis spinosa var. *nummularia*																									
Capparis umbonata																								+	
Cassytha capillaris					+			+			+	+		+					+						
Cenchrus ciliaris																									
Centipeda minima subsp. *macrocephala*																									
Centipeda minima subsp. *minima*																									
Cheilanthes brownii																									
Chrysocephalum apiculatum																									
Cleome viscosa																									
Clerodendrum floribundum var. *angustifolium*																									
Clerodendrum tomentosum var. *lanceolatum*																									

Species	BC01	BC02	BC03	BC04	BC05	BC06	BC07	BC08	BC09	BC11	BC12	BC13	BC14	BC15	BC16	BC20	BC23	BC26	BC33	BC36	BC37	BC38	BC39	BC40	BC42
Corchorus parviflorus	Assoc.		+		+	+		+	2%		+	+		+											
Corchorus walcottii																									
Corymbia candida subsp. *dipsodes*								Assoc.																	
Corymbia deserticola subsp. *deserticola*																		+			+				
Corymbia hamersleyana		+		Assoc.					2%	+				+						1%			+		
Cucumis variabilis																									
Cullen lachnostachys																									
Cymbopogon ambiguus	Assoc.				+						+														
Cynanchum floribundum																									
Cyperus hesperius					+						(+)														
Cyperus ixiocarpus					1%			+																	
Dampiera candicans	+									+	+			+	+	+		+					+		+
Dodonaea coriacea	+	Assoc.	+	+	+					+								+			+				+
Dysphania plantaginella																									
Dysphania rhadinostachya subsp. *rhadinostachya*																									
Ehretia saligna var. *saligna*																									
Enneapogon lindleyanus																									
Eragrostis cumingii					+																				
Eragrostis eriopoda									(+)																
Eremophila latrobei subsp. *latrobei*									+																
Eriachne benthamii	Assoc.													+											
Eriachne lanata																									
Eriachne mucronata	1%			+	+	+	+	+			+					+									
Eucalyptus camaldulensis subsp. *refulgens*																									
Eucalyptus leucophloia subsp. *leucophloia*	2%	2%	7%	3%		+	1%			+	2%		2%	1%	+	1%	1%	1%	1%	1%	1.5%	1%			2%
Eucalyptus victrix					+																				
Euphorbia australis var. *subtomentosa*					+																				
Euphorbia boophthona								+																	
Euphorbia careyi																									
Evolvulus alsinoides var. *villosicalyx*																									
Ficus brachypoda					+																				
Gompholobium oreophilum	+	+	+	+		Assoc.				+		+	+		1%			+		+	+		2%		1%
Gonocarpus ephemerus								+			+														
Goodenia cusackiana							+					+	+												
Goodenia lamprosperma																									
Goodenia microptera			+																						
Goodenia stobbsiana		+	+	+		+	+			(+)		+	+		+	+		+			+	+	+		+
Goodenia triodiophila				+			+																		
Gossypium australe																									
Grevillea berryana																									
Grevillea pyramidalis subsp. *leucadendron*																									
Grevillea wickhamii subsp. *hispidula*	4%	+	+	Assoc.	+	+	+	+	1%	1%	1%	2%		3%	+	0.5%	+	+		+	+		+		+
Hakea chordophylla																			+						
Hakea lorea subsp. *lorea*																		+				+			
Haloragis gossei var. *gossei*																			+						
Heliotropium chrysocarpum																									
Heliotropium skeleton																									
Hibiscus coatesii																									
Hibiscus sturtii var. *campylochlamys*									+	+				+											
Hybanthus aurantiacus								+						+											
Indigofera monophylla			+		+			+	1%		+			1%						+			+		
Isotropis atropurpurea														+											
Lepidium pedicellosum																									
Maireana carnosa																									
Maireana melanocoma																									
Maireana tomentosa subsp. *tomentosa*																						+			
Melaleuca argentea																									
Melaleuca eleuterostachya																									

Species	BC01	BC02	BC03	BC04	BC05	BC06	BC07	BC08	BC09	BC11	BC12	BC13	BC14	BC15	BC16	BC20	BC23	BC26	BC33	BC36	BC37	BC38	BC39	BC40	BC42
Melaleuca glomerata	Assoc.							7%			8%														
Mollugo molluginea			(+)				+													+			+		
Nicotiana benthamiana																									
Petalostylis cassioides						Assoc.				+	+	1%		1%											
Petalostylis labicheoides																									
Phyllanthus maderaspatensis								+			+			+											
Pluchea dentex	+				+			+	+		+			+											
Pluchea ferdinandi-muelleri																									
Pluchea rubelliflora																									
Pluchea tetranthera			Assoc.						+																
Podolepis capillaris									+																
Polycarpaea holtzei																									
Potamogeton tricarinatus																									
Pterocaulon sphaeranthoides																									
Ptilotus astrolasius																									
Ptilotus axillaris																									
Ptilotus calostachyus							+					+											+	+	
Ptilotus fusiformis					(+)									+											
Ptilotus incanus																									
Ptilotus nobilis subsp. *nobilis*																									
Ptilotus wilsonii																									
Rhodanthe margarethae																									
Salsola australis																									
Santalum lanceolatum									+																
? *Sauropus* sp.					+																				
Scaevola browniana subsp. *browniana*									+					+											
Schenkia clementii																									
Sclerolaena eriacantha																									
Senna glaucifolia		+	+	+			+						+				+		+	+		+			+
Senna glutinosa subsp. *glutinosa*	Assoc.				+					+	+					+				+					
Senna glutinosa subsp. *luerssenii*													Assoc.												
Senna glutinosa subsp. *pruinosa*																									
Senna notabilis									+																
Sida arenicola																									
Sida echinocarpa																									
Sida fibulifera																									
Sida sp. Pilbara (A.A. Mitchell PRP 1543)			+											+							+				
Solanum ? *horridum*											+														
Solanum phlomoides						+																			
Solanum sp.																									
Solanum sturtianum																									
Sporobolus australasicus																									
Stemodia grossa						+																			
Stemodia viscosa	Assoc.										+														
Streptoglossa decurrens																									
Swainsona stenodonta																									
Synaptantha tillaeacea var. *tillaeacea*																									
Tephrosia supina			Assoc.																						
Tinospora smilacina																									
Trachymene oleracea subsp. *oleracea*																									
Trianthema glossostigma																									
Tribulus suberosus																									
Trichodesma zeylanicum var. *zeylanicum*					+																				
Triodia brizoides		4%	25%	6%			18%						8%				22%	40%	50%	10%	15%	15%	5%	5%	7%
Triodia epactia	20%	3%	20%	6%	10%	6%	5%	15%	7%	15%	8%	8%	5%	18%	20%	15%	22%		+	4%	25%	35%	15%	30%	+
Triodia longiceps							12%																		
Waltheria indica									+																
Waltheria virgata								+	1%					1%											

Species	BC44	BC46	BC47	BC48	BC49	BC50	BC52	BC53	BC54	BC55	BC56	BC57	BC58	BC59	BC61	BC62	BCR17	BCR19	BCR22	BCR24	BCR25	BCR27	BCR29	BCR34	BCR35	BCR60
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)																								+		
Acacia acradenia																									+	
Acacia adoxa var. *adoxa*				+	+	+						+		+	+			+			+				+	+
Acacia adsurgens	+			3%		2%						+												+		
Acacia ancistrocarpa																										
Acacia aphanoclada																										
Acacia aphanoclada x *pyrifolia* var. *pyrifolia*																										
Acacia bivenosa										+																
Acacia colei var. *colei*																										
Acacia coriacea subsp. *pendens*									+																	
Acacia cyperophylla var. *omearana*																										
Acacia dictyophleba												+														
Acacia hilliana		+		1%	+	+							+		1%	+		+			+	+				+
Acacia maitlandii																										+
Acacia monticola	3%	Assoc.	1%	+		4%					5%	+		+		+	7%		+	1%				+		
Acacia orthocarpa	+											+		+		20%			1%					+		
Acacia pruinocarpa																										
Acacia pyrifolia var. *pyrifolia*		+	+	+	+					+	+	Assoc.	+	+	+			+	+	+		+		+	+	+
Acacia retivenea subsp. *clandestina*	1%				+						+						+									
Acacia sp.																										
Acacia spondylophylla				+	Assoc.	+				1%		+	2%	1%	6%	1%		+				+				+
Acacia stellaticeps																										
Acacia synchronicia																							+			
Acacia synchronicia (broad phyllode variant)																										
Acacia trachycarpa																							1%			
Acacia trachycarpa x ? *monticola*																										
Acacia trachycarpa x ? *tumida*				+																						
Acacia tumida var. *pilbarensis*	1%			1%				+			5%	5%	+	70%				+		3%			1%		5%	
Aerva javanica																										
Alternanthera nana									+																	
Amaranthus sp.	(+)																									
Ammannia auriculata								+																		
Ammannia baccifera								+	+																	
Aristida contorta																										
Aristida holathera var. *holathera*																										
Atalaya hemiglauca																								+		
Atriplex codonocarpa																										
Bergia pedicellaris							+																			
Bonamia erecta																										
Bonamia media													+		+	+									+	
Bonamia rosea																										
Bulbostylis barbata			+	+							+															
Calandrinia quadrivalvis								+				Assoc.														
Calocephalus beardii																										
Calotropis procera																							+			
Calytrix carinata																		+								
Capparis spinosa var. *nummularia*																										
Capparis umbonata																										
Cassytha capillaris																										
Cenchrus ciliaris																								+		
Centipeda minima subsp. *macrocephala*							+		0.5%																	
Centipeda minima subsp. *minima*								+																		
Cheilanthes brownii																								+		
Chrysocephalum apiculatum							+	+	0.5%																	
Cleome viscosa																										
Clerodendrum floribundum var. *angustifolium*																										
Clerodendrum tomentosum var. *lanceolatum*											+															

Species	BC44	BC46	BC47	BC48	BC49	BC50	BC52	BC53	BC54	BC55	BC56	BC57	BC58	BC59	BC61	BC62	BCR17	BCR19	BCR22	BCR24	BCR25	BCR27	BCR29	BCR34	BCR35	BCR60
Corchorus parviflorus	1%		+	+	+	1%		+			+															
Corchorus walcottii																										
Corymbia candida subsp. *dipsodes*																										
Corymbia deserticola subsp. *deserticola*					Assoc.													+							+	
Corymbia hamersleyana														1%				+	+			+				+
Cucumis variabilis																								+		
Cullen lachnostachys																										
Cymbopogon ambiguus	1%		1%	+							+	Assoc.											+	2%	+	
Cynanchum floribundum																										
Cyperus hesperius	+		+	+							+													+		
Cyperus ixiocarpus								+				1%														
Dampiera candicans					+	+							+	+												+
Dodonaea coriacea		Assoc.		+	+								+		+			+				+			+	+
Dysphania plantaginella									+																	
Dysphania rhadinostachya subsp. *rhadinostachya*																										
Ehretia saligna var. *saligna*																								+		
Enneapogon lindleyanus																										
Eragrostis cumingii																										
Eragrostis eriopoda																										
Eremophila latrobei subsp. *latrobei*																										
Eriachne benthamii												+														
Eriachne lanata															+											
Eriachne mucronata	1%		+	Assoc.		+					1%	1%		+						+				+	+	
Eucalyptus camaldulensis subsp. *refulgens*							5%	8%	6%														1%			
Eucalyptus leucophloia subsp. *leucophloia*	1%	1%		+	4%	+				+		1%	2%	2%	1.5%	+	+	+	1%		1%	2%		1%	1%	+
Eucalyptus victrix												+														
Euphorbia australis var. *subtomentosa*												+														
Euphorbia boophthona																										
Euphorbia careyi																								+		
Evolvulus alsinoides var. *villosicalyx*																										
Ficus brachypoda																									1%	
Gompholobium oreophilum		Assoc.		+	Assoc.	+					+			+		2%		+	+		+	4%			+	+
Gonocarpus ephemerus								+																		
Goodenia cusackiana													+								+	+				
Goodenia lamprosperma							+	+	1%																	
Goodenia microptera																										
Goodenia stobbsiana		Assoc.			+	+							+		+	+		+							+	+
Goodenia triodiophila														+				+			+					+
Gossypium australe																										
Grevillea berryana																										
Grevillea pyramidalis subsp. *leucadendron*															+											
Grevillea wickhamii subsp. *hispidula*	1%		+	+		2%				+	1%	+		6%		1%	+	+	+	1%					+	
Hakea chordophylla																										
Hakea lorea subsp. *lorea*																										+
Haloragis gossei var. *gossei*																										
Heliotropium chrysocarpum									+																	
Heliotropium skeleton																										
Hibiscus coatesii																										
Hibiscus sturtii var. *campylochlamys*																										
Hybanthus aurantiacus																										
Indigofera monophylla												+		1%									+			
Isotropis atropurpurea															+											
Lepidium pedicellosum																								+		
Maireana carnosa																										
Maireana melanocoma																										
Maireana tomentosa subsp. *tomentosa*																										
Melaleuca argentea									1%																	
Melaleuca eleuterostachya																										

Species	BC44	BC46	BC47	BC48	BC49	BC50	BC52	BC53	BC54	BC55	BC56	BC57	BC58	BC59	BC61	BC62	BCR17	BCR19	BCR22	BCR24	BCR25	BCR27	BCR29	BCR34	BCR35	BCR60
Melaleuca glomerata							15%	4%	3%			+														
Mollugo molluginea																										
Nicotiana benthamiana																								+		
Petalostylis cassioides	+													+												
Petalostylis labicheoides											+												7%			
Phyllanthus maderaspatensis																										
Pluchea dentex				+				+				+		+										+		
Pluchea ferdinandi-muelleri										+																
Pluchea rubelliflora									0.5%																	
Pluchea tetranthera										+																
Podolepis capillaris																										
Polycarpaea holtzei																										
Potamogeton tricarinatus							+																			
Pterocaulon sphaeranthoides																										
Ptilotus astrolasius																										
Ptilotus axillaris																										
Ptilotus calostachyus					+										+			+								+
Ptilotus fusiformis			+									+														
Ptilotus incanus																										
Ptilotus nobilis subsp. *nobilis*																										
Ptilotus wilsonii																										
Rhodanthe margarethae																								+		
Salsola australis																										
Santalum lanceolatum														+												
? *Sauropus* sp.																										
Scaevola browniana subsp. *browniana*																										
Schenkia clementii								+	+																	
Sclerolaena eriacantha																										
Senna glaucifolia		+			+					+			+		+				+		+				+	+
Senna glutinosa subsp. *glutinosa*	+		+		+						+			+	+							+		+		
Senna glutinosa subsp. *luerssenii*																										
Senna glutinosa subsp. *pruinosa*																										
Senna notabilis																										
Sida arenicola														+											+	
Sida echinocarpa												Assoc.														
Sida fibulifera	+																									
Sida sp. Pilbara (A.A. Mitchell PRP 1543)																								+		
Solanum ? *horridum*																								+		
Solanum phlomoides																										
Solanum sp.																									+	
Solanum sturtianum																										
Sporobolus australasicus																										
Stemodia grossa																										
Stemodia viscosa								+						+												
Streptoglossa decurrens																										
Swainsona stenodonta																										
Synaptantha tillaeacea var. *tillaeacea*																										
Tephrosia supina													+													
Tinospora smilacina																								+		
Trachymene oleracea subsp. *oleracea*																										
Trianthema glossostigma									+																	
Tribulus suberosus											+	Assoc.														
Trichodesma zeylanicum var. *zeylanicum*																										
Triodia brizoides		12%			20%					20%			20%		35%			15%	7%		20%	15%			3%	12%
Triodia epactia	20%	+	15%	20%		32%	8%	5%			15%	8%	+	15%		20%	12%		7%	15%	+				4%	+
Triodia longiceps																							4%			
Waltheria indica																										
Waltheria virgata																										

APPENDIX I

LOCATION OF CONSERVATION SIGNIFICANT FLORA

Note: All records WGS84, Zone 51K

Species	Easting	Northing	Number of Individuals
Acacia aphanoclada (Priority 1)	199514	7580254	6
	199652	7580356	8
	200907	7580543	13
	200862	7580539	10
	200801	7580547	6
	200746	7580501	3
	200786	7580469	8
	200811	7580495	13
	200847	7580468	25
	200876	7580459	13
	200925	7580488	26
	200973	7580544	8
	200999	7580527	24
	201013	7580522	44
	201054	7580514	20
	201061	7580492	33
	201040	7580450	19
	201016	7580432	28
	200972	7580426	11
	200946	7580458	17
	200892	7580411	10
	200858	7580395	10
	200803	7580438	6
	200740	7580430	9
	200695	7580441	9
	200674	7580443	5
	200697	7580411	10
	200714	7580386	8
	200810	7580348	32
	200856	7580343	15
	200897	7580350	15
	200933	7580370	25

Species	Easting	Northing	Number of Individuals
Acacia aphanoclada (Priority 1)	200969	7580375	15
	201022	7580376	55
	201085	7580417	1
	201039	7580349	33
	201000	7580350	10
	200971	7580347	15
	200921	7580343	20
	200896	7580329	10
	200847	7580324	12
	200815	7580309	15
	200789	7580247	15
	200869	7580274	13
	200896	7580280	8
	200941	7580308	20
	200982	7580300	14
	201028	7580302	10
	201031	7580265	20
	201003	7580267	10
	200963	7580279	8
	200930	7580270	6
	200886	7580247	13
	200833	7580223	22
	200767	7580210	10
	200794	7580179	12
	200887	7580210	6
	200955	7580222	20
	200984	7580219	15
	201009	7580215	20
	201129	7580224	3
	201165	7580190	10
	201054	7580175	20
	201025	7580178	15
	200998	7580171	8
	200949	7580173	10
	201032	7580058	10
	201070	7579947	10

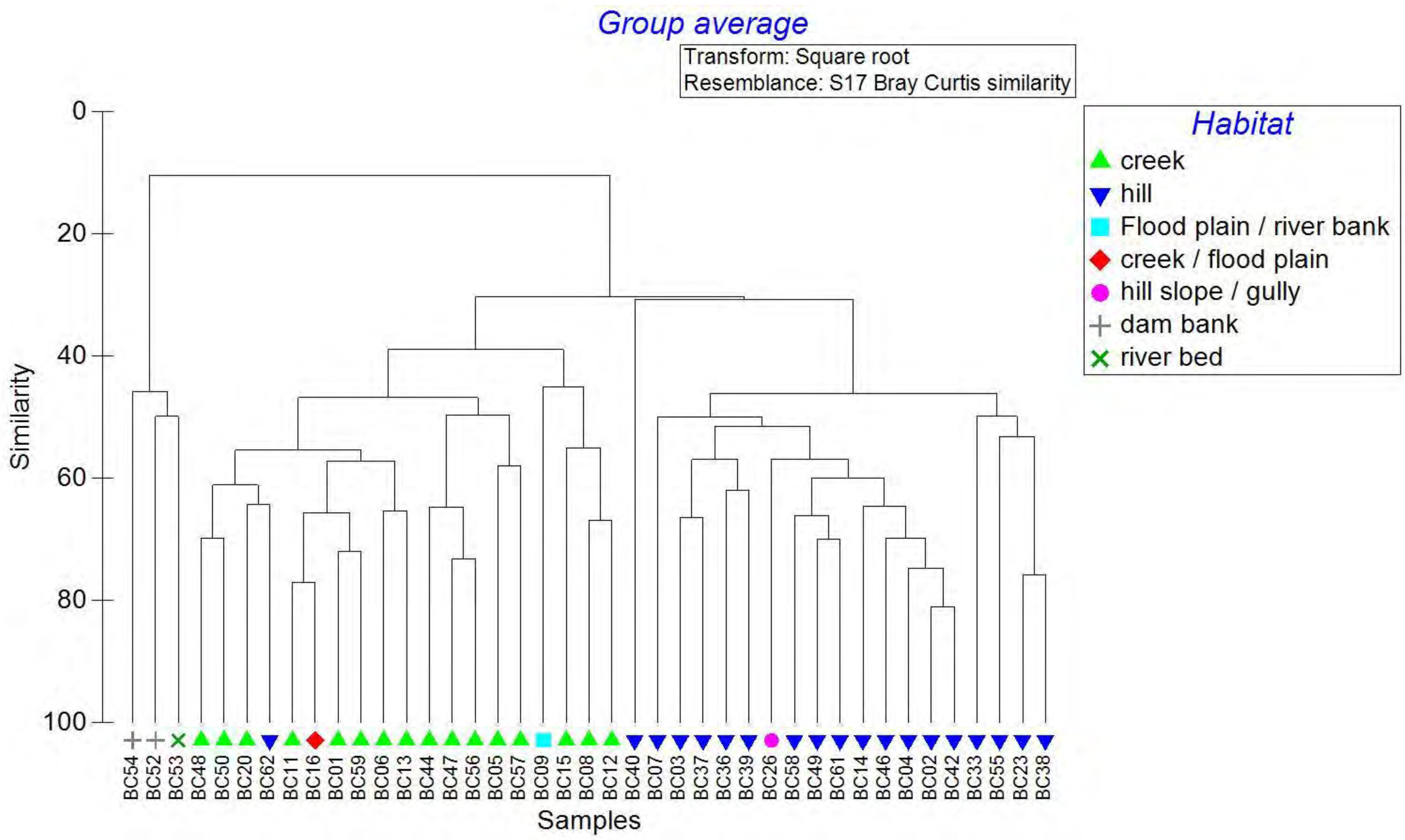
Species	Easting	Northing	Number of Individuals
Acacia aphanoclada (Priority 1)	201025	7579958	20
	201100	7579931	8
	199955	7580387	4
	199900	7580471	15
	201059	7579801	20
	201078	7579753	16
	201014	7579739	25
	200964	7579694	1
	201263	7579753	6
	201348	7579634	8
	201396	7579555	3
	200996	7577361	4
	200985	7577403	8
	201013	7577444	15
	201069	7577478	10
	200223	7577622	2
	200033	7577229	15
	200094	7577093	20
	200148	7577042	12
	200220	7577022	7
	200248	7576960	2
	200273	7577052	6
	200397	7577051	6
	200093	7576957	1
	200032	7577011	14
	199972	7577071	20
	199955	7577118	10
	199719	7577099	10
	199772	7577191	14
	199791	7577307	8
	199835	7577325	14
	199847	7577368	8
	199937	7577447	6
	200776	7577716	3
	200723	7577773	8
	200561	7576892	1

Species	Easting	Northing	Number of Individuals
Acacia aphanoclada (Priority 1)	199827	7580397	2
	199795	7580335	8
	199705	7580233	14
	199185	7580456	12
	199110	7580486	20
	199575	7580390	18
	199752	7580420	4
	200773	7577713	3
	201227	7580339	1
	201217	7580389	10
	201250	7580453	3
	201301	7580512	16
	201308	7580381	4
	201345	7580279	2
	201357	7580239	1
	201394	7580183	15
	201435	7580188	2
	201495	7580220	8
	201527	7580263	2
	201602	7580292	8
	201684	7580279	6
	201650	7580157	3
	201598	7580087	4
	201551	7580053	2
	201490	7579948	5
	201411	7579970	2
	201235	7580059	20
	201217	7580009	47
	201218	7579965	26
	201149	7579928	5
	201186	7579887	3
	201159	7580161	15
	201074	7577604	2
	201156	7577563	2
	201124	7577545	11
	201094	7577501	7

Species	Easting	Northing	Number of Individuals
Acacia aphanoclada (Priority 1)	199373	7580117	5
	201233	7580268	15
Acacia cyperophylla var. *omearana* (Priority 1)	198657	7577175	1
	198624	7577181	1
	198618	7577181	1
Ptilotus wilsonii (Priority 1)	200778	7577517	1
	199359	7577352	1

APPENDIX I

STATISTICAL ANALYSIS DENDROGRAM



APPENDIX B

Vertebrate Fauna Survey

360 environmental

Beatons Creek

Baseline Vertebrate Fauna Survey

Prepared for:

Novo Resources

March 2015

people planet professional

Document Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
684 AB	A INTERNAL DRAFT	LS	RF	1 Electronic (email)	20/02/15
684 AB	B CLIENT REPORT	LS	FJ & BW	1 Electronic (email)	29/03/15

Executive Summary

360 Environmental Pty Ltd (360 Environmental) was commissioned by Novo Resources in August 2014 to undertake a Level 2 vertebrate fauna survey at Beatons Creek (survey area). The survey area is approximately 1,172 ha, adjacent to Nullagine in the Pilbara, approximately 1,300 km north east of Perth Western Australia (WA).

The vertebrate fauna survey was conducted between 30 September and 10 October 2014. Survey effort at six trap sites consisted of 420 pitfall trap-nights, 840 funnel trap-nights, 420 Elliott trap-nights and 168 cage trap-nights. A total of six person hours of systematic bird surveys, 44 person hours of opportunistic bird surveys and 18 person hours of nocturnal spotlighting was conducted at the trap sites, with nine nights of Song Meter 2 (SM2) acoustic recording (two units) surveys for micro bats.

Database searches (Department of Parks and Wildlife (DPaW), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool and NatureMap) returned 259 vertebrate species from 82 families. Of these, eight were amphibians from three families, 85 were reptiles from nine families, 120 were bird species from 50 families and 46 were mammals, from 20 families.

A total of 27 conservation significant fauna species (including Priority species) were identified during the desktop review of database searches. Two were reptile species, from the Scincidae and Boidae families. 17 were bird species from the following 13 familes: Apodidae, Ardeidae, Accipitridae, Falconidae, Otididae, Burhinidaea, Charadriidae, Rostratulidae, Scolopacidae, Psittacidae, Strigidae, Meropidae, and Maluridae. Eight conservation significant mammal species were recorded from the following six families: Dasyuridae, Thylacomyidae, Megadermatidae, Notoryctidae, Hipposideridae and Muridae.

During the field survey, 65 species were recorded. These comprised of 22 species of reptile, from eight families, 29 bird species from 21 families and 14 mammal species from seven families.

Five species of conservation significance were directly observed during the field survey, the Black-lined Ctenotus which is listed as Priority 1 under the *Wildlife Conservation Act 1950* (WC Act), the Rainbow Bee-eater, which is listed as Migratory under the EPBC Act and Schedule 4 under the WC Act, the Western Pebble-mouse, which is listed as Priority 4 by DPaW, the Pilbara Leaf-nosed bat which is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act and the Northern Quoll which is listed as Endangered under the EPBC Act and Schedule 1 under the WC Act.

In total four fauna habitats were identified in the survey area. These include Drainage Line, Hill, Dam and Degraded Mining Area. Habitat condition throughout the survey area ranged from Completely Degraded to Pristine. Drainage Line comprised 5.03% of the survey area, Hill habitat included 78.51% of the survey area, Dam comprised 1.56% and Degraded Mining Area included 14.90% of the survey area.

Permits

This fauna survey was conducted under the following licences issued by DPaW; Regulation 17 Licence to take fauna for scientific purposes SF010023 issued to Dr Ron Firth.

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1 Introduction

1.1 The Project

360 Environmental Pty Ltd (360 Environmental) was commissioned by Novo Resources Corp (Novo) in August 2014 to undertake a single phase Level 2 terrestrial vertebrate survey at Beaton's Creek (the survey area). The survey area is approximately 1,172 ha, adjacent to Nullagine in the Pilbara, and approximately 1,200 km north east of Perth, Western Australia (WA) (Figure 1).

1.1.1 Objectives

The objectives of the Level 2 terrestrial vertebrate survey were to:

- Conduct a comprehensive desktop assessment of fauna databases and relevant literature;
- Undertake a baseline vertebrate survey in order to characterise fauna in the survey area;
- Undertake a targeted conservation significant fauna survey, to map, estimate the population extent, describe and determine local and regional significance of conservation significant fauna in the survey area;
- Verify accuracy of the desktop assessment through ground truthing;
- Undertake habitat assessment and prepare habitat mapping including mapping of conservation significant fauna habitat where and when relevant (critical habitat); and
- Compilation of a fauna inventory.

Legend

Survey Area

Towns

- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

SLIP ENABLER

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

360 environmental

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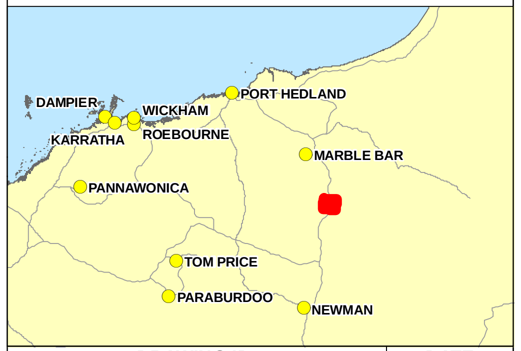
0 1 2 3
Kilometers
1:60,000 @ A3

LOCALITY MAP



DRAWING ID	DATE
684_f3a_fauna_habitats.mxd	27-Feb-2015

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
CS	LS/RF	RF/FJ	0

Novo Resources
Beatons Creek, Nullagine

Baseline Vertebrate Fauna Survey

Figure 1 **Site Location**

K:\Projects\1.0 EBS\684 Beatons Creek Fauna\Figures

1.2 Background to the Protection Fauna

Fauna is protected formally and informally by various legislative and non-legislative measures, which are as follows:

Legislative measures:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Wildlife Conservation Act 1950* (WC Act); and
- *Environmental Protection Act 1986* (EP Act).

Non-legislative measures:

- WA Department of Parks and Wildlife (DPaW) Priority lists for flora, ecological communities and fauna; and
- Recognition of locally significant populations by the DPaW.

A short description of each is given below. Other definitions, including species conservation categories, are provided in Appendix A.

1.2.1 EPBC Act

The EPBC Act aims to protect matters of national environmental significance, which are detailed in Appendix A. Under the EPBC Act, the Commonwealth Department of the Environment (DotE) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are considered to be conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered and Vulnerable, etc.), or Migratory.

Bird species protected as Migratory under the EPBC Act include those listed under international migratory bird agreements relating to the protection of birds which migrate between Australia and other countries, for which Australia has agreed. This includes the: Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Some marine fauna or terrestrial fauna that use marine habitats are listed as Marine under the EPBC Act. These species are only considered conservation significant when a proposed development occurs in a Commonwealth marine area (i.e. any Commonwealth Waters or Commonwealth Marine Protected Area). Outside of such areas the EPBC Act does not consider these species to be matters of national environmental significance, so are not protected under the Act. As such species only listed as Marine under the EPBC Act have not been considered to be conservation significant in this assessment.

1.2.2 WC Act

The WA DPaW, lists taxa under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 4 according to their need for protection (see Appendix A). The WC Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

1.2.3 EP Act

Significant habitat necessary for the maintenance of fauna indigenous to Western Australia as well as TECs are given special consideration in environmental impact assessment, and areas covered by TECs have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

1.2.4 DPaW Priority Lists

The DPaW lists 'Priority' fauna that have not been assigned statutory protection as 'Scheduled' under the WC Act, but which are under consideration for declaration as 'Scheduled' fauna. Fauna assessed as Priority 1-3 are considered to be in urgent need of further survey. Priority 4 fauna require monitoring every 5-10 years and Priority 5 fauna are subject to a specific conservation program (Appendix A).

In addition, the DPaW maintains a list of Priority Ecological Communities which identifies those communities that need further investigation before possible nomination for TEC status.

Although DPaW Priority species and communities have no formal legal protection, they are under consideration as 'Scheduled' taxa under the WC Act or as ESAs under the EP Act Informal Recognition of Fauna.

1.2.5 Informal Recognition of Threatened Fauna

Certain populations or communities of flora may be of local significance or interest because of their patterns of distribution and abundance. For example fauna may be locally significant because they are range extensions to the previously known distribution, or are newly discovered taxa (and have the potential to be of more than local significance). In addition, many species are in decline as a result of threatening processes (land clearing, grazing, changed fire regimes), and relict populations of such species assume local importance for the DPaW. It is not uncommon for the DPaW to make comment on these species of interest.

2 Biophysical Environment

2.1 Climate

The survey area is in the Pilbara region of WA. The Pilbara has an arid-tropical climate with two distinct seasons, a hot and wet summer from October to April and a mild winter from May to September. Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland. Winter rainfall is commonly the result of cold fronts moving north-easterly across the State (Bureau of Meteorology [BoM] 2014).

The nearest public climate data is available from the BoM Marble Bar and Noreena Downs Station weather stations located 85 km north-north-west and 45 km south, respectively, of the survey area. Long term rainfall data has been recorded at Noreena Downs since 1911. More reliable data for temperatures and recent rainfall has been recorded at Marble Bar.

The average annual maximum temperature for Marble Bar is 35°C and the average annual minimum temperature is 20°C. In summer, mean monthly maximum temperatures reach 41.5°C, and in winter mean monthly minimum temperatures fall to 12°C. Noreena Downs have recorded an average annual rainfall of 325 mm from 1911-2014. While rainfall is often sporadic, and can occur throughout the year, Noreena Downs receives 71% of its total annual rainfall during the wet season from December to March (BoM 2014) (Figure 2).

For the three months preceding the survey (June 2014 to August 2014), Marble Bar received 51 mm of rainfall, compared with the long-term average rainfall of 35.6 mm (1911-2014) for the same period. This constitutes 15.4 mm and 43% more than the long term average.

Rainfall for the 12 months before the survey (September 2013 to August 2014) at Marble Bar was 547 mm compared with 325 mm for the long-term average (1911-2014) for the same period. This constitutes 222 mm or 70% more than the long term average.

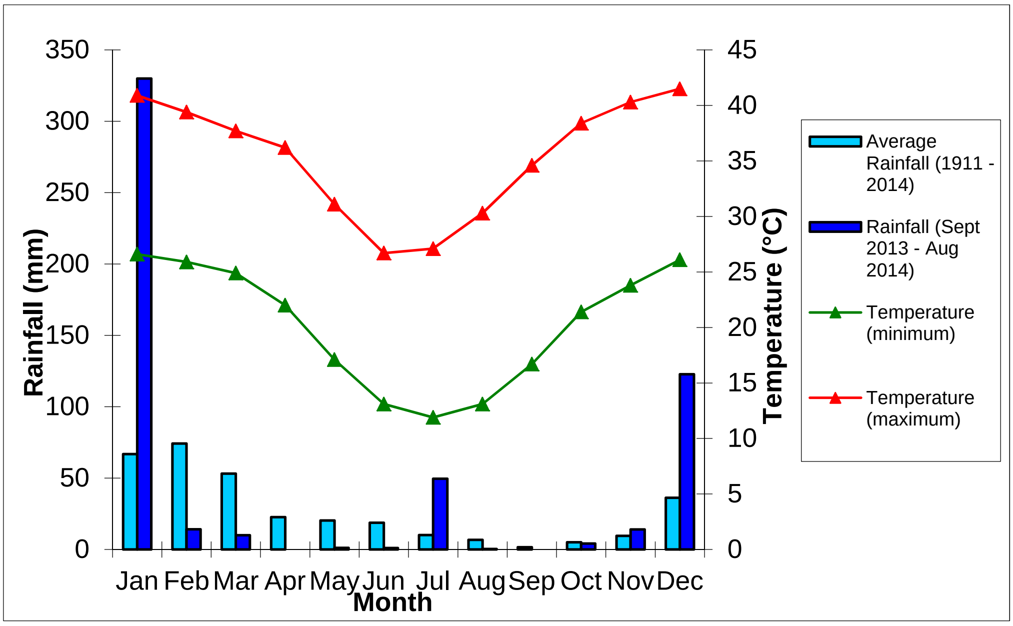


Figure 2: Average long term (1911-2014) Rainfall for Noreena Downs Station and 2013/14 monthly rainfall and average maximum temperatures (2000-2014) for Marble Bar (BoM 2014).

2.2 Soils

The survey area was mapped at a scale of 1:1,000,000 by Tille (2006) as the Hamersley Plateaux zone. This zone is characterised by hills and dissected plateaux (with areas of stony plains and hardpan wash plains) on sedimentary and volcanic rocks of the Hamersley Basin (Ophthalmia Fold Belt). There are also areas of stony soils red shallow loams, red/brown non-cracking clays and red loamy earths.

2.3 Geology

The following geological units occur in the survey area, based on mapping by the Geological Survey of WA (1968):

- Jeerinah Formation (1): Pillowed and massive basaltic flows; and basaltic breccia; metamorphosed;
- Jeerinah Formation (2): Undivided; mudstone; siltstone; sandstone; chert; massive basaltic flows; basaltic pillow lava; basaltic breccia; and minor felsic volcaniclastic rock; intruded by numerous dolerite sills; metamorphosed;
- Wittenoom Formation: thin- to medium-bedded dolomite, dolomitic mudstone, chert, and felsic to mafic volcanic sandstone; metamorphosed;
- Marra Mamba Iron Formation: chert, banded iron-formation, mudstone, and siltstone; metamorphosed;

- Mount McRae Shale and Mount Sylvia Formation: mudstone, siltstone, chert, banded iron-formation, and dolomite; metamorphosed;
- Brockman Iron Formation: banded iron-formation, chert, mudstone, and siltstone; metamorphosed;
- Weeli Wolli Formation: banded iron-formation (often jaspilitic), mudstone, siltstone, and numerous dolerite sills; metamorphosed; and
- Dolerite dyke or sill.

2.4 Landforms and Hydrology

The survey area is situated across an area of steep to undulating hills with broad to incised gullies intersecting the hills. A dammed water reservoir is located near the eastern boundary and as far as we are aware was constructed by Nullagine locals (pers. comm. Bill Edwards, Nullagine resident) in the 1980's and is not a drinking water source but is used recreationally for swimming. A large area in the south eastern portion of the survey area has been previously disturbed with historical mining activity. The primary water flow in the northern portion of the survey area flows west to east into a channel that flows south into the reservoir. Surface water in the southern third of the survey area flows towards the town of Nullagine. Beatons Creek is situated just south of the southern boundary of the survey area, flowing west to east into the Nullagine River.

2.5 Biogeographic Regionalisation for Australia

The Biogeographic Regionalisation of Australia (IBRA7) divides Australia into 89 bioregions based on major biological and geographical/geological attributes. These bioregions are subdivided into 419 subregions, as part of a refinement of the IBRA framework (DotE 2014a).

The survey area is located across the Chichester subregion (PIL1) of the Pilbara bioregion (DotE 2014a). The Chichester subregion is characterised by Archaean granite and basalt plains with a shrub steppe of *Acacia inaequilatera* over *Triodia wiseana* hummock grassland and *Eucalyptus leucophloia* tree steppe on the ranges (Kendrick & McKenzie 2001). This subregion comprises the entirety of the survey area.

2.6 Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The Pilbara bioregion (Pilbara) as defined by IBRA covers an area of approximately 178,088 km^2. Land system mapping classifies the Pilbara into 106 land systems captured across three studies (Payne *et al.* 1988; Payne & Tille 1992; Van Vreeswyk *et al.* 2004).

The survey area occurs in association with two land systems: Capricorn and Mosquito Land Systems. Further details of these land system are presented in Table 1.

Table 1: Land Systems of the survey area (Van Vreeswyk al.2004)

LAND SYSTEM	DESCRIPTION	AREA OF LAND SYSTEM IN THE PILBARA BIOREGION	
		AREA (KM^2)	% OF PILBARA BIOREGION
Capricorn	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands.	5,296 km^2	2.9%
Mosquito System	Stony plains and prominent ridges of schist and other metamorphic rocks supporting hard spinifex grasslands.	1,840 km^2	1%

2.7 Broad Vegetation Types

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Burbidge (1959) and by Beard (1975), and was re-assessed by Shepherd *et al.* (2001) to account for clearing in the intensive land use zone, and divided some larger vegetation units into smaller units.

The survey area is situated in the Hamersley Plateau, which forms part of the Fortescue Botanical Province in the Eremaean Botanical Province of WA (Beard 1975). The survey area includes two broad vegetation types (Beard [1975] / Shepherd *et al.* [2001]):

- 173 [a2Sr t1,3Hi] - Hummock grasslands, shrub steppe; kanji over soft spinifex & Triodia wiseana on basalt; and
- 190 [a6, 7Sb t3Hi] - Hummock grasslands, sparse shrub steppe; Acacia bivenosa & A. trachycarpa over hard spinifex, Triodia wiseana, Very poor rocky country on gneiss.

2.8 Previous Biological Studies

In recent decades, an increase in resource development projects has resulted in a significant amount of site-specific (i.e. local scale) biological survey work being carried out, most of which is undertaken for approvals under the EP Act.

A major systematic field survey of biodiversity by the Department of Environment and Conservation (DEC) (now known as DPaW) in the Pilbara was conducted during 2002-2007 (McKenzie *et al*. 2009). These biodiversity surveys included (among other fauna groups) systematic sampling of small mammals, micro bats and birds (Gibson & McKenzie 2009, McKenzie & Bullen 2009, Burbidge *et al*. 2010).

Some examples of recent past consultant fauna surveys undertaken in the vicinity of the survey area can be seen in Table 2. These recent examples include a level 2 survey (ENV. Australia 2012), a targeted Pilbara Leaf–nosed Bat (PLNB) survey (Bamford

Consulting Ecologists 2013a) and a level 1 and targeted conservation significant survey (Bamford Consulting Ecologists 2013b).

Table 2: Summary of available recent fauna surveys undertaken in the vicinity of the survey area.

SURVEY	SURVEY TYPE	SURVEY DATE	METHODS	KEY FINDINGS: SIGNIFICANT SPECIES
Bamford Consulting Ecologists (2009) Fauna Assessment of the BC Iron Nullagine Direct Shipping Ore Project	Unknown	2008	o Unknown	o Northern Quoll (*Dasyurus hallucatus*)
Ninox Wildlife Consulting (2011) A Vertebrate Fauna Survey of Proposed Satellite Mining Areas, near Nullagine, WA	Level 2 survey	Autumn and Spring 2010	o Trap lines, pitfall, cage, Elliott and funnel trapping; active searches, bird survey, bat survey (AnaBat)	o Australian Bustard (*Ardeotis australis*) o Rainbow Bee-eater (*Merops ornatus*) o Brush-tailed Mulgara (*Dasycercus blythi* o Bilby (*Macrotis lagotis*) o Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia)* o Black-lined Ctenotus (*Ctenotus nigrilineatus*)

SURVEY	SURVEY TYPE	SURVEY DATE	METHODS	KEY FINDINGS: SIGNIFICANT SPECIES
ENV. Australia (2012) Christmas Creek Terrestrial Vertebrate Fauna and Fauna Habitat Assessment	Level 2 survey	16 – 27 March 2011	o Trapping grids, pitfall, cage, Elliott and funnel trapping; active searches, spotlighting; bird survey; bat survey (SM2)	o Pilbara Olive Python (*Liasis olivaceus barroni*) o Rainbow Bee-eater (*Merops ornatus)* o Australian Bustard (*Ardeotis australis)* o Western Star Finch (*Neochmia ruficauda subclarescens*)
Bamford Consulting Ecologists (2013) Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) surveys of the Warrigal North Deposit	Targeted survey	18 – 23 Oct 2012 14 – 22 May 2013	o SM2 and AnaBat detectors (Passive i.e. set in one location overnight) o SM2 and AnaBat detectors (Active i.e. walking transects with units) o Roost searches	o PLNB calls were recorded from 16 sites o PLNB calls recorded in 3 caves
Bamford Consulting Ecologists (2013) BC Iron Nullagine Project Extension Areas – Bonnie East, Warrigal North and Coongan	Level 1and targeted conservation species	22 - 23 May 2012	o Opportunistic observations of fauna (particularly birds); and	o Grey Falcon (*Falco hypoleucos*)

SURVEY	SURVEY TYPE	SURVEY DATE	METHODS	KEY FINDINGS: SIGNIFICANT SPECIES
Assessment of Fauna Values	assessments		o Search for evidence of conservation significant fauna	

3 Methods

3.1 Background

The single phase Level 2 fauna survey was compliant with the EPA requirements for the environmental survey and reporting of fauna in WA and relevant EPBC Act survey guidelines, where practical and relevant, and as set out in the following documents:

- Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3 (EPA 2002);
- Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56 (EPA 2004);
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA-DEC 2010);
- Survey Guidelines for Australia's Threatened Bats. EPBC Act survey guidelines 6.1 (2010) (DSEWPaC);
- Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2 (2010) (DSEWPaC);
- Survey Guidelines for Australia's Threatened Frogs. EPBC Act survey guidelines 6.3 (2010) (DSEWPaC);
- Survey Guidelines for Australia's Threatened Mammals. EPBC Act survey guidelines 6.5 (2011) (DSEWPaC);
- Survey Guidelines for Australia's Threatened Reptiles. EPBC Act survey guidelines 6.6 (2011) (DSEWPaC);
- EPBC Act Policy Statement 3.25. Referral guidelines for the endangered northern quoll, *Dasyurus hallucatus* (2011) (DSEWPaC); and
- Dunlop, J., Cook, A., & Morris, K. (2014). DPaW, Pilbara northern quoll regional monitoring guidelines, Department of Parks and Wildlife, Perth.

3.2 EPBC Act Referral Guidelines

The significant impact guidelines provide overarching guidance on determining whether an action is likely to have a significant impact on a matter of national environmental significance protected by the EPBC Act. In the Pilbara region, the only vertebrate fauna species that has specific referral guidelines is the Northern Quoll (*Dasyurus hallucatus*).

3.3 Fauna Survey Methods

3.3.1 Fauna Database Review

Searches of DPaW's threatened fauna database (50 km radial search), EPBC Protected Matters Search Tool (50 km radial search), and NatureMap (the maximum available 39 km radial searches) were undertaken to identify fauna species of conservation significance potentially occurring in the survey area (DPaW 2014a, DotE 2014b; DPaW 2014b).

Collectively, these sources were used to compile a list of species that have been previously recorded in the vicinity of the survey area (Appendix B). This list invariably includes some species that do not occur in the survey area, as some fauna have a limited or patchy distribution or a high level of habitat specificity for habitats which are not located in the survey area. These fauna were examined and then excluded from the list where relevant. The database results are presented in Appendix C.

3.3.2 Field Survey

The field survey was undertaken for a total of 11 days from 30 September – 10 October 2014. Four staff (Principal Zoologist, Zoologist and two Field Assistants) initially set up the trap sites, which included, trap site selection, digging of pitfall traps and fences and the laying out of Elliott and cage traps. After four days, the two Field Assistants returned to Perth.

The field survey was consistent with standard protocols for the region and relevant WA EPA Guidance Statements and EPBC Act Survey Guidelines as outlined above in section 3.1 (where relevant and practical).

The purpose of the field survey was to verify the accuracy of the desktop assessment and to further delineate and characterise the fauna assemblages and fauna habitat in the survey area. The field survey consisted primarily of a baseline trapping programme, fauna habitat assessment, spotlighting and opportunistic observations. Transects on foot were also undertaken across the survey area.

3.3.3 Baseline Trapping Programme

A total of six trap sites (systematic sample units) were sampled in a range of habitats. Data collected systematically (i.e. where methods and effort are the same per sample unit) can be analysed to determine patterns in the richness, abundance and composition of the fauna. Trap sites were selected to obtain a broad coverage of the habitats available in the survey area and to be readily accessible in order to check traps in a timely manner (Table 3).

The trapping programme was carried out over seven nights at each of the trap sites with the same survey effort (time, number of traps and search effort [defined as person hours]). Three of the trap sites consisted of a 100 m x 100 m (1 ha) quadrats and the other three trap sites were linear transects of equivalent area along drainage lines.

In each quadrat and linear transect a total of 10 pitfall traps (20 L buckets) were set with drift fence. These consisted of two lines of five pitfall traps at 5 m intervals, each with a 30 m section of drift fence. A total of 20 funnel traps were set along the sides of the drift fence (10 at each pitfall line), with 10 Elliott and four cage traps spaced equidistantly around the perimeter of the quadrat (Figure 3).

Overall trap effort for the survey area was 420 pitfall trap nights 840 funnel trap nights, 420 Elliott trap nights and 168 cage trap nights.

Table 3: Trap site locations

Trap Site	Trap Layout		Easting	Northing
1	Linear Transect	Western end of transect	0200837	7579938
		Eastern end of transect	0200777	7580081
2	Linear Transect	Western end of transect	0201101	7579566
		Eastern end of transect	0200994	7579550
3	Quadrat		0200456	7579793
4	Quadrat		0799348	7577650
5	Linear Transect	Western end of transect	0199816	7178006
		Eastern end of transect	0199937	7578104
6	Quadrat		0199269	7577262

3.3.4 Habitat Assessment

Vegetation communities and landforms were used to identify the broad fauna habitats in the survey area. Habitat assessments were undertaken in each quadrat, in the linear transect and at an additional five other locations in the survey area. Broad fauna habitats in the survey area based on vegetation structure and landforms, were identified during the field survey. These fauna habitats were then assessed for their potential to support species of conservation significance and the quality of habitat they provide to a wider suite of fauna. The habitat assessments were documented systematically for each habitat type on standardised field sheets (Appendix D).

A total of seven, 100 x 100 m quadrats and four linear transect habitat assessments were completed during the survey (Figure 3). Each broad habitat type description includes information on:

- Location of the broad habitat type within the survey area (GPS co-ordinate) and its relative percentage;
- Habitat condition was assessed at each trap site as 'completely degraded through to pristine, based on the scale given in Keighery (1994);
- Landscape position;

- Dominant vegetation and structure e.g. number of vegetation strata;
- Hollow-bearing trees and dead stags (e.g. average size and abundance of hollows);
- Description of any rock and rocky outcrops;
- Logs (e.g. abundance and size);
- Substrate (e.g. leaf litter);
- Wetlands, creeks, rivers, dams and other water bodies;
- Description of any observed nests and roosts;
- Subterranean roosts (e.g. caves, disused mineshafts and/or adits);
- Associated fauna species observed using the habitat;
- Disturbance e.g. cattle grazing, fire; and
- Photo showing a typical example of the broad habitat type.

The location of the habitat assessments are presented in Figure 4.

3.3.5 Opportunistic Observation

Fauna were opportunistically observed and recorded during the assessment. The opportunistic data supplements the systematic data collected at trap sites (Appendix E). A total of 44 person hours of opportunistic searches was undertaken and these were mainly bird focused. They also involved targeted searches of habitats including rocky outcrops, drainage lines, caves, adits, rock piles, hills, dam and gorge that potentially support fauna of conservation significance.

During the opportunistic searches the following techniques were used: raking through leaf litter, overturning rocks, looking under decorticating bark, investigating burrows, tracks and scats.

Opportunistic observation also included searching for mounds of the Western Pebble-mouse (*Pseudomys chapmani*), caves and adits for the PLNB (*Rhinonicteris aurantia*), and Northern Quoll (*Dasyurus hallucatus*) scats and possible den sites i.e. rock overhangs and caves.

In addition, opportunistic records of fauna species encountered while travelling between trap sites was also documented. Opportunistic data comprises records of fauna species by location (coordinates taken with a GPS as in the case of Western Pebble-mouse mounds, Pilbara Leaf-nosed Bat and Northern Quoll scats).

3.3.6 Nocturnal Spotlighting

Spotlighting and head torching at night from vehicles and on foot is an important survey tool as much of the region's fauna is nocturnal and/or crepuscular, particularly conservation significant species such as the Northern Quoll. At each of the six trap sites a total of 1- person hour of nocturnal searches was conducted (two fieldworkers searching for 30 minutes each), totalling six hours across the systematic sites. In addition spotlighting was also conducted from vehicles while driving between trap sites (12 person hours).

3.3.7 Bat Monitoring

Bat recordings were undertaken at night, using Wildlife Acoustic Song Meter 2 (SM2) recording units to document bat species in the area. Where possible, methodology follows recommendations in the EPBC Act *Survey Guidelines for Australia's Threatened Bats* (Department of the Environment, Water, Heritage and the Arts 2009). The recording units convert ultrasonic echolocation signals produced by bats into audible electronic signals, which are later analysed to identify species-specific calls.

A total nine nights of bat calls were recorded using SM2 recording units. Sampling evenings were hot and dry with minimum overnight temperatures between 20 and 25^{O}C. The moon in this period was full. These conditions correspond to typical levels of bat echolocation detection for the season.

When positioning the SM2 units, feature such as caves, adits, potential flyways, tree lines and rocky areas were considered to be preferable locations where bats might roost and forage. The locations of the SM2 units are presented in Table 4 and Figure 4.

Bob Bullen of Bat Call WA completed analysis of echolocation recordings. Bat activity was then characterised as "Low", "Medium" or "High" based on the rate of call sequences recorded:

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes;
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a at least an hour followed by sporadic records for the remainder of the session; and
- High species activity refers to call recording more often than two minutes apart for at least two hours followed by reasonably regular records for the remainder of the session.

Table 4: Sm2 unit locations (co-ordinates are in UTMs [GDA94])

	SM2 12801	
DATE	EASTINGS	NORTHINGS
4-5/10/2014	020022	7577708
6/10/2014	199269	7577262
7/10/2014	199991	7577674
9/10/2014*	199851	7577636
	SM2 11793	
4/10/2014	200285	7577941
5/10/2014	200838	7579935
6/10/2014	199868	7578015
7/10/2014*	201090	7579556

* PLNB calls were recorded on these units on these dates.

3.3.8 Motion Sensitive Camera

Ten motion sensitive cameras were setup during the field survey. The cameras were setup for a minimum of one night at seven separate locations. The cameras were typically positioned in areas that are likely to support species of conservation significance, for example in areas where potential Northern Quoll den sites may occur. The motion sensitive camera locations are presented in Table 5 and Figure 4.

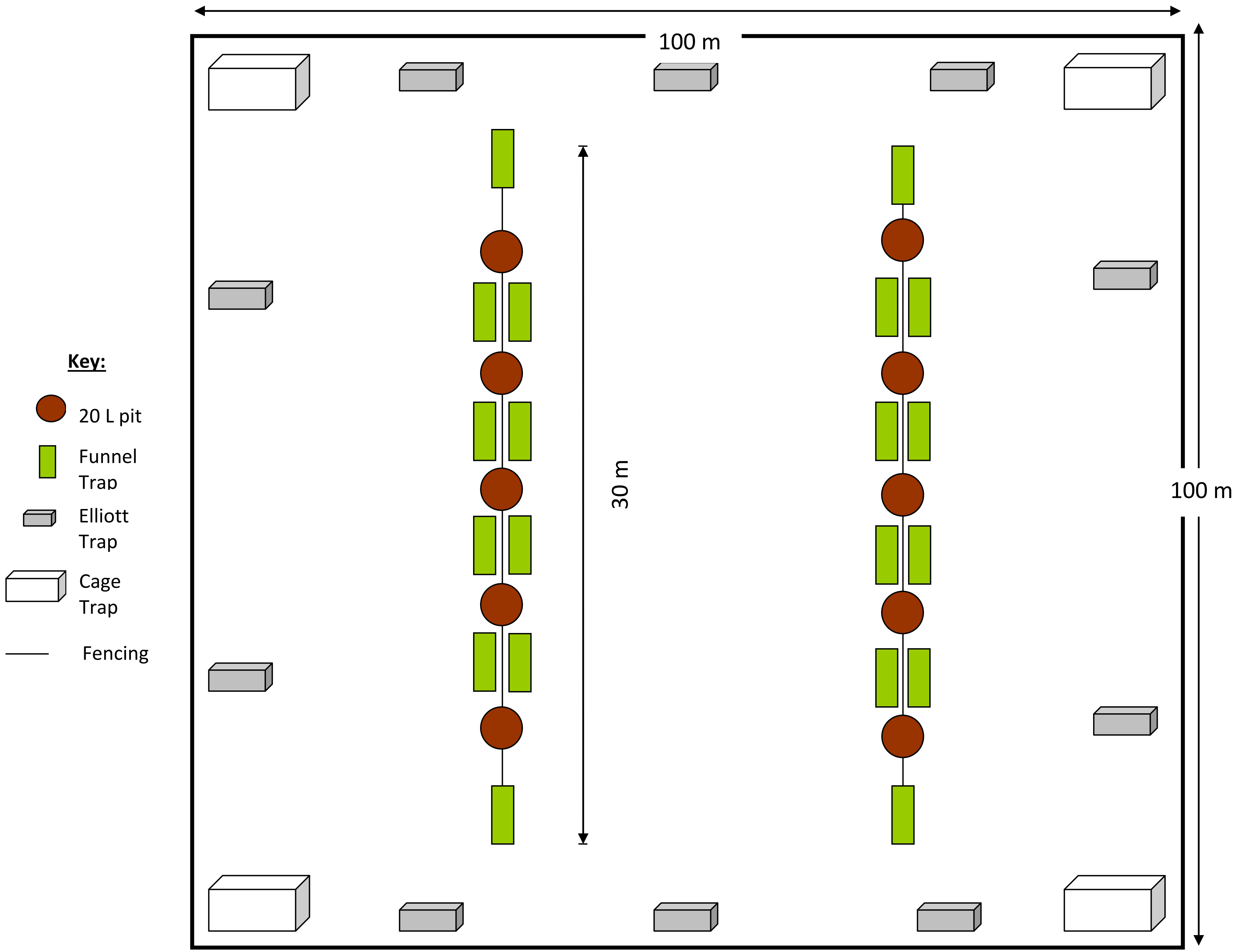
Table 5: Motion sensitive camera locations (co-ordinates in UTMs [GDA94])

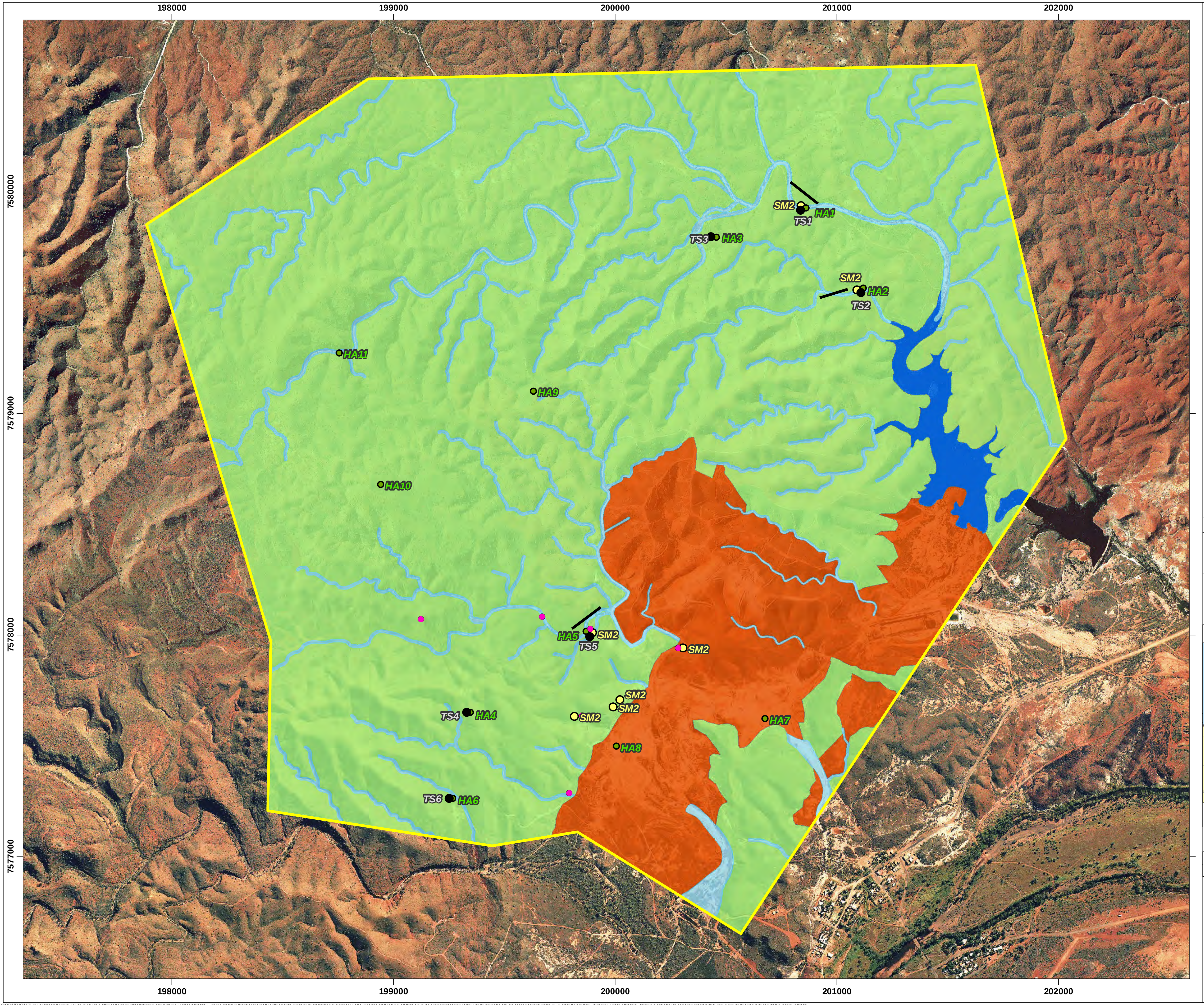
EASTING	NORTHING	DATES
0200285	7577941	4 – 6 October
0199671	7578082	6 October
0199793	7577287	6 October
0199870	7578016	6 October
0199124	7578070	7 October
0199851	7577636	9 October
0199269	7577262	6 & 7 October

3.3.9 Taxonomy

Where there is doubt on species names identified in the desktop assessment, (through subsequent name changes or taxonomic reviews), an effort was made to determine the current scientific name for each taxon. In some cases, old scientific names may be presented where correct nomenclature could not be determined due to name changes. Some taxon names may be followed by 'sp.', meaning that the species name was not given in the data source or the identification is in doubt. Where there are previously recorded taxa such as this that have the potential to be a conservation significant species, they are discussed specifically in the results and discussion section.

Taxonomy and nomenclature in this report follows the accepted listing of published terrestrial vertebrate species. The listing for amphibians and reptiles follows Cogger (2013), birds follows Christidis & Boles (2008) and mammals Van Dyck & Strahan (2008).


100 m
100 m
30 m
Key:
20 L pit
Funnel Trap
Elliott Trap
Cage Trap
Fencing



Legend

- Survey Area
- Trap Site
- Habitat Assessment
- SM2 Unit
- Camera Traps
- Transects

Fauna Habitat

- Hill
- Degraded Mining Area
- Drainage Area
- Dam

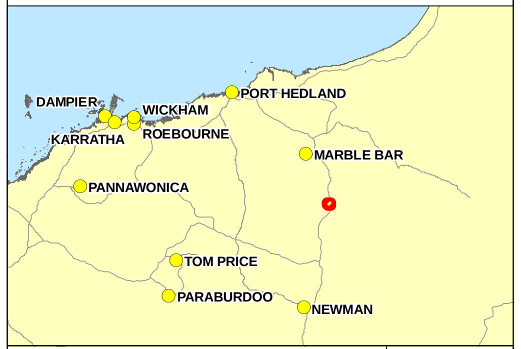
- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

0 200 400 600 800
Meters
1:16,000 @ A3

LOCALITY MAP



DRAWING ID	DATE
684_f3a_fauna_habitats.mxd	10-Feb-2015

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
CS	LS/RF	RF/FJ	0

Novo Resources
Beatons Creek, Nullagine

Baseline Vertebrate Fauna Survey

Figure 4 Fauna Habitat

K:\Projects\1.0 EBS\684 Beatons Creek Fauna\Figures

4 Results

4.1 Fauna Survey Limitations and Constraints

Survey constraints are often difficult to predict, as is the extent to which they influence survey effort. Survey limitations and constraints of the fauna survey are outlined below in Table 6.

Table 6: Limitations and constraints associated with the survey

Variable	Impact on Survey Outcomes
Access	The survey area is 1,172 ha and a large proportion of it was accessed and explored. The six trap sites were representative of the fauna habitats found throughout the survey area.
Experience	The personnel who executed these surveys were practitioners suitably qualified in their respective fields: • Coordinating Zoologist, Field Staff and Report Review: Dr Ron Firth (Principal Zoologist); • Field Staff, Data Interpretation and Reporting: Laura Stevens (Zoologist); • Field Assistant: Chris Kleiber; and • Field Assistant: Paul Robertson.
Timing, weather, season	The survey was undertaken from the 30 September to 10 October 2014 which is appropriate for the Pilbara (EPA-DEC 2010). The average annual maximum temperature for Marble Bar is 35°C and the average annual minimum temperature is 20°C. In summer, mean monthly maximum temperatures reach 41.5°C, and in winter mean monthly minimum temperatures fall to 12°C. For the three months preceding the survey (June 2014 to August 2014), Marble Bar received 51 mm of rainfall, compared with the long-term average rainfall of 35.6 mm (1911-2014) for the same period. This constitutes 15.4 mm and 43% more than the long term average. Rainfall for the 12 months before the survey (September 2013 to August 2014) at Marble Bar was 547 mm compared with 325 mm for the long-term average (1911-2014) for the same period. This constitutes 222 mm and

Variable	Impact on Survey Outcomes
	70% more than the long term average
Scope: Life forms sampled	This was a single phase Level 2 survey, comprising a desktop review of secondary data and a field survey that included baseline trapping, habitat assessments, systematic and opportunistic observations, bat survey and motion sensitive camera trapping.
Sources of information	The desktop analysis used several sources to produce a list of fauna species previously recorded in the vicinity of the survey area. This includes records from the DPaW Threatened Fauna Database Search, (DPaW 2014a), and EPBC Protected Matters Search Tool (DotE 2014b) and NatureMap (DPaW 2014b) as well as past consultant reports, field guides and other scientific literature.
Completeness	A total 259 fauna species were recovered from database searches and a total of 65 species were recorded during the survey. A total of six 1 ha trap sites were surveyed over seven nights. Total survey effort for the six trap sites was 420 pitfall trap-nights, 840 funnel trap-nights, 420 Elliott trap-nights, and 168 cage trap-nights. A total of 6 person hours of systematic bird surveys, 44 person hours of opportunistic survey, and 18 person hours of nocturnal spotlighting was conducted at the trap sites and in the survey area, with nine nights of acoustic bat recording (two units) and ten nights of motion sensitive camera traps.
Disturbances	There has been ongoing mining activity in the survey area for numerous years, consequently, parts of the survey area are disturbed and degraded. Two of the habitat assessments were undertaken in areas that were degraded as a result of mining activities.

4.2 Fauna Results

4.2.1 Database Results

Database searches returned 259 vertebrate species from 82 families. Of these, eight were amphibians from three families, 85 were reptiles from nine families, 120 were bird species from 50 families and 46 were mammals, from 20 families (this includes micro bats).

A total of 27 conservation significant species (including Priority species) were identified during the desktop review of database searches (Table 7 and Appendix C). These comprised two reptile species, 17 bird species, and eight mammal species, and the likelihood of them occurring in the survey area is outlined in Table 7 and mentioned in the discussion.

4.2.2 Conservation Significant Fauna

A total of 27 conservation significant species (including Priority species) were identified during the desktop review of the database searches. Of these, five were recorded during the survey, seven were considered Likely to occur in the survey area, five were considered Possible and ten considered Unlikely to occur (Table 7). All 27 conservation significant species are discussed in section 5.2.

The Likelihood of each species is based on the following criteria:

- Recorded: Recorded during the field survey or site reconnaissance;
- Likely: Suitable habitat is present in the survey area and the survey area is in the species' known distribution;
- Possible: Limited or no suitable habitat is present in survey area, but is nearby. The species has good dispersal abilities and is known from the general area; and
- Unlikely: No suitable habitat is present in survey area but is nearby, the species has poor dispersal abilities, but is known from the general area; or suitable habitat is present, however the survey area is outside of the species' known distribution.

Table 7: Conservation significant fauna recorded and potentially occurring in the survey area

En = Listed as Endangered under the EBPC Act, Vu = Listed as Vulnerable under the EBPC Act, Mi = Listed as Migratory under the EBPC Act, Ma = Listed as Marine under the EBPC Act, S = Scheduled (1 - 4) under the WC Act, P = Listed as Priority (1 – 5) by DPaW.

Species	Conservation Status	Likelihood
Black-lined Ctenotus (*Ctenotus nigrilineatus*)	P1	Recorded
Rainbow Bee-eater (*Merops ornatus*)	MiMa, S4	Recorded
Northern Quoll (*Dasyurus hallucatus*)	En, S1	Recorded
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form)	Vu, S1	Recorded
Western Pebble-mouse (*Pseudomys chapmani*)	P4	Recorded
Pilbara Olive Python (*Liasis olivaceus barroni*)	Vu	Likely
Australian Bustard (*Ardeotis australis)*	P4	Likely
Sharp-tailed Sandpiper (*Calidris acuminata*)	MiMa	Likely

Species	Conservation Status	Likelihood
Eastern Great Egret (*Ardea modesta*)	MiMa	Likely
Wood Sandpiper (*Tringa glareola*)	MiMa	Likely
Ghost bat (*Macroderma gigas*)	P4	Likely
Grey Falcon (*Falco hypoleucos*)	S1	Possible
Peregrine Falcon (*Falco peregrinus*)	S4	Possible
Bush Stone-curlew (*Burhinus grallarius)*	P4	Possible
Australian Painted Snipe (*Rostratula australis*)	En, MiMa	Possible
Barking Owl (*Ninox connivens*)	P2	Possible
Fork-tailed Swift (*Apus pacificus*)	MiMa, S4	Unlikely
Cattle Egret (*Ardea ibis*)	MiMa	Unlikely
Oriental Plover (*Charadrius veredus*)	MiMa	Unlikely
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	MiMa, S3	Unlikely
Night Parrot (*Pezoporus occidentalis*)	Vu	Unlikely
Princess Parrot (*Polytelis alexandrae*)	Vu, P4	Unlikely
Striated Grasswren (inland) (*Amytornis striatus striatus*)	P4	Unlikely
Brush-tailed Mulgara (*Dasycercus blythi*)	P4	Unlikely
Long-tailed Dunnart (*Sminthopsis longicaudata*)	P4	Unlikely
Bilby (*Macrotis lagotis*)	Vu, S1	Unlikely
Northern Marsupial Mole (*Notoryctes caurinus*)	En, S1	Unlikely

4.2.3 Survey Results

During the field survey 65 species from 36 families were recorded. This consisted of 22 species of reptiles from eight families, 29 bird species from 21 families and 14 mammal species from seven families.

4.2.4 Fauna Assemblage

4.2.4.1 Amphibians

From the database searches, eight amphibians have previously been recorded in the surrounding area and in the survey area; however, no amphibians were recorded during this survey.

Most of the systematic sites were on hills and those that were in drainage lines had no water present during the survey. Frogs may have been present around the dam, but during spotlighting none were seen or heard. However, the dam was not a focus during the survey and so spotlighting effort at the dam was not extensive. Survey effort was focussed on areas to be impacted by the proposed mining activities and where the likelihood of detecting conservation significant species was greater.

4.2.4.2 Reptiles

From the database searches, a total of eighty-five species of reptile have been previously recorded in the surrounding area. During the field survey 22 species of reptile were recorded (Appendix B) (Plates of some non-conservation significant reptile species can be found in Appendix F). We have graphed the frequency of captures from trap sites for all reptiles species caught using pitfalls and funnels traps during the survey (Figure 5). (Note, this graph does not include species such as the Perentie (*Varanus giganteus*) or a King Brown snake (*Pseudechis australis*), both seen incidentally). We have not produced frequency graphs for birds or mammals because the number of bird observations and calls (recorded systematically in the trap sites), and the captures of mammals in traps was insufficient to result in a meaningful graph.

The most numerous reptile species captured was the Stony-soil Ctenotus (*Ctenotus saxatilis)* which was recorded on 22 occasions, across five of the trap sites. The Ring-tailed Dragon (*Ctenophorus caudicinctus*) was the second most captured reptile, being recorded on 14 occasions, across four of the trap sites. The third most captured reptile recorded was the Priority 1 Black-lined Ctenotus, being recorded on ten occasions across four of the trap sites. The fourth most numerous reptile was the Tree Dtella (*Gehyra variagata*), which was recorded on eight occasions, across four of the trap sites. The remaining 18 reptile species were all recorded on less than six occasions (Figure 5).

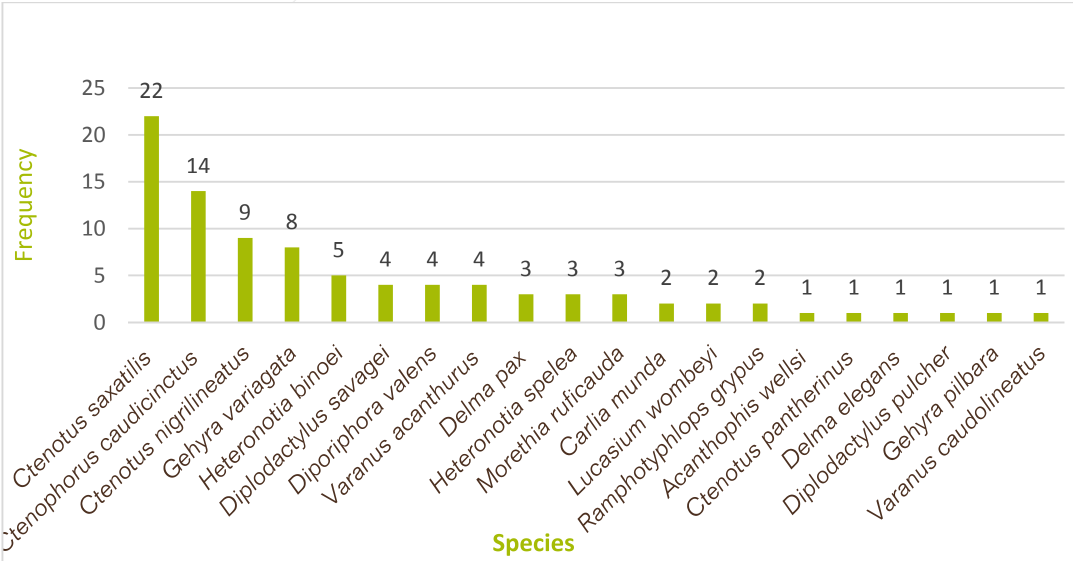


Figure 5: Frequency of reptile species recorded at trap sites during the field survey

4.2.4.3 Birds

From the database searches, a total of 120 bird species have been previously recorded in the surrounding area. During the field survey 29 species of bird were recorded (Appendix B). The most frequently incidentally recorded birds were the Spinifex Pigeon (*Geophaps plumifera)*, which was mainly observed in small groups, walking along the edges of tracks. The Willie Wagtail (*Rhipidura leucophrys*) and the Torresian Crow (*Corvus orru*) which were observed flying overhead, sitting in trees and heard calling. These species were all seen daily and throughout the entire survey area. The Black Swan (*Cygnus atratus*), was also one of the most frequently recorded birds, however, these recordings were limited to the dam. (Plates of some non-conservation significant bird species can be found in Appendix F). A large flock (approximately 20 individuals) of the EPBC Act listed Rainbow Bee-eater was opportunistically recorded during the survey.

4.2.4.4 Mammals

From the database searches 46 species of mammal have previously been recorded in the vicinity of the survey area (Appendix C). During the field survey fourteen species of mammal were recorded (Appendix B). (Plates of some non-conservation significant mammal species can be found in Appendix F). During the field survey the most frequently recorded mammal was the Euro (*Macropus robustus*). The Euro was observed in small groups of up to three individuals, mainly in Hill habitat. The second most numerous mammal recorded was the Desert Mouse (*Pseudomys desertor*), with eight captures across the trap sites. One Western Pebble-mouse was also captured in an Elliott trap at Trap Site 4 and two disused mounds were recorded (Figure 6).

4.2.4.5 Fauna Habitat

Four broad fauna habitats types were identified in the survey area:

- Hill;
- Degraded Mining Area;
- Drainage Line (including some minor gorges); and
- Dam.

These fauna habitats are discussed more fully in section 5.3. They are mapped in Figure 4 and the habitat assessment sheets are detailed in Appendix D. The extent of each habitat in the survey area is presented in Table 8. Of the four habitats, Hill was the most extensive, comprising 78.51% of the survey area.

Table 8: Habitat types and extent in the survey area

Habitat	Extent in The Survey area (HA)	Extent in The Survey area (%)
Hill	920.31	78.51
Degraded Mining Area	174.64	14.90
Drainage Line	59.01	5.03
Dam	18.29	1.56
Total Survey area	1,172.25	100

Hill

Hill habitat was typically comprised of *Eucalyptus leucophloia* and *Corymbia hamersleyana* scattered low trees over mixed *Acacia hilliana*, *A. orthocarpa* and *A. spondylophylla*, over *Triodia brizoides* and *Triodia epactia*. There was a lower diversity of microhabitats in this habitat with few large trees, few if any tree hollows, few if any hollow logs, and little woody debris. The soil was hard and unsuitable for burrowing fauna as there was exposed bedrock (limited small piles of rock) providing cracks and crevices which are important shelter sites for small ground dwelling reptiles and some small mammals. As such this habitat type is considered to be of moderate value.

Plates 1 & 2: Hill habitat in the survey area

Degraded Mining Area

Almost 15% of the survey area is classed as Degraded Mining Area and was either cleared or completely degraded. Habitat was typically comprised of *Acacia spp.* and *Triodia spp.* (both with limited cover), roads, tracks, mine pits, borrow pits and all areas that have been cleared of vegetation as a result of historic mining activity or as part of the exploration programme for this current project.

This habitat provides limited value to most fauna, however, some of the commonly recorded and widespread bird species were seen in this habitat, for example the Spinifex Pigeon, Torresian Crow and Black Kite. This habitat type is considered to be of limited value as there is little vegetation (limited cover), no trees with hollows and very little woody debris.

Plates 3 & 4: Degraded Mining Area habitat in the survey area

Drainage Line

The Drainage Lines and minor gorges are combined as one habitat type because they are similar in landform structure (both have exposed rock i.e. including some rock walls and piles, crevices and cracks), both have soft sandy soil in the stream beds as a result of erosion and sedimentation. There are also similarities in plant species composition and structure, consequently the fauna that utilise these habitats are similar to some extent. In general the Drainage Lines intersect the survey area in a north to south direction, therefore water tends to flow off the hills towards the Nullagine River to the south east of the survey area.

The vegetation in this habitat is characterised as a Woodland of *Eucalyptus victrix* and *Eucalyptus camaldulensis* (though there were relatively few eucalypts) over *Melaleuca glomerata*, *Acacia pyrifolia*, and *A. tumida*.

Microhabitats present in this habitat include tree hollows (though very limited), few hollow logs (and only small logs), some leaf litter, relatively greater vegetation cover (mostly comprised of *M. glomerata* and *Acacia spp.*) and soft soils suitable for digging by burrowing fauna. The mature Eucalyptus trees in this habitat are larger than trees in the surrounding hills, therefore this habitat may act as a wildlife corridor. In particular, birds, bats, large mammals (such as the Euro) and reptiles (such as snakes and goannas) are likely to use the drainage line as a wildlife corridor. Consequently, this habitat type is considered to be the highest habitat value relative to the others in the survey area.

Plate 5: Drainage Line Habitat in the survey area

Plate 6: Drainage Line Habitat in the survey area

Dam

The dam occurs in the north east of the survey area and as mentioned in section 2.4 it was constructed by Nullagine locals in the 1980s for recreational purposes.

The vegetation in this habitat is dominated by *E. camaldulensis* and *Melaleuca argentea* around the edges of the dam. Microhabitats in this artificial habitat include leaf litter, thick vegetation around the perimeter of the dam and soft soil.

The soft substrate is suitable for burrowing and digging animals and the all year water provides foraging opportunities for some migratory shorebirds and resident waterbirds. This habitat type is considered to be of moderate habitat value.

Plate 7: Dam Habitat in the survey area

Plate 8: Dam Habitat in the survey area

4.2.4.6 Acoustic Bat Results

SM2 recording units were set up about caves and in Drainage Line and Hill habitat which had been identified as potential bat roosting or foraging sites. Two units were used, over a total of nine nights. The coordinates of SM2 locations were recorded with a GPS.

The bat survey calls were identified by Bob Bullen from Bat Call WA and the results are presented in Appendix G.

A total of eight bat species calls were recorded in the survey area:

- Pilbara Leaf-nosed Bat (PLNB) (*Rhinonicteris aurantia*);
- Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*);
- Common Sheath-tailed Bat (*Taphozous georgianus*);
- Northern Free-tailed Bat (*Chaerephon jobensis*);
- Beccari's Free-Tailed Bat (*Mormopterus lumsdenae*);
- Gould's Wattled Bat (*Chalinolobus gouldii*);
- Little Broad-nosed Bat (*Scotorepens greyii*); and
- Inland Cave Bat (*Vespadelus finlaysoni*).

The PLNB were detected in low numbers on SM2 units at two locations (Table 8 and Figure 6). The PLNB are further discussed below in section 5.2.

Plate 9: SM2 Unit

Plate: 10: Placement of SM2 Unit inside potential Bat Roost (old adit)

4.2.4.7 Motion Camera Results

One Northern Quoll (*Dasyurus hallucatus*) was captured on a motion camera at one location during the survey (Figure 6, Table 9, and Plate 11). This species is listed as Endangered under the EPBC Act and will be discussed in more detail in section 5.2. No other animals were captured on motion cameras during the survey.

Plate 11: Northern Quoll captured on motion camera

5 Discussion

5.1 Fauna Databases

The composition and current status of the vertebrate fauna of the Pilbara is relatively well known because of several broad-scale systematic fauna surveys (Gibson & McKenzie 2009; McKenzie & Bullen 2009; Burbidge *et al.* 2010; Doughty *et al*. 2011; Johnstone *et al.* 2013) and numerous surveys by consultants. Compared to other IBRA bioregions in Australia, the vertebrate fauna of the Pilbara is characterised by a species-poor amphibian fauna, however, it is one of the richest bioregions for reptiles with a high level of endemism (Doughty *et al*. 2011; Pepper *et al.* 2013), and has moderate levels of bird and mammal species richness (Atlas of Living Australia 2011).

Since European settlement, 12 mammal species have become extinct in the region, two species persist only on its coastal islands (Western Chestnut Mouse [*Pseudomys nanus*] and Pale Field-rat [*Rattus tunneyi*]) and one (Water Rat [*Hydromys chrysogaster*]) has contracted to the coast (Burbidge *et al*. 2009, Baynes & McDowell 2010). Habitat loss is considered to be the main threat to fauna species in the Pilbara (Evans *et al.* 2011). However, habitat degradation by cattle grazing and changed fire regimes (van Vreeswyk *et al.* 2004), and predation by introduced predators such as cats and foxes, are typically implicated in the decline of many conservation significant species occurring in the Pilbara (Abbott 2009).

Many of the species retrieved from the databases are unlikely to occur in the survey area on a regular basis as these records are from a large area encompassing a wide range of habitats. In addition, many fauna are not distributed evenly across the landscape, are more abundant in some places than others are, and consequently more detectable (Currie 2007). Furthermore, some small, common ground-dwelling reptile and mammal species tend to be habitat specific, and many bird species can occur as regular migrants, occasional visitors or vagrants.

It is also important to note, however, that the EPBC Protected Matters Search Tool is not entirely based on point records, but also on broader information, for example bioclimatic distribution models. Whereas DPaW's NatureMap and threatened fauna database are based on point records, consequently, the results of the EPBC Protected Matters Search Tool are in some cases less accurate, particularly at a local scale.

A total of 27 conservation significant fauna species (including Priority species) were either recorded during the survey or identified during the desktop review of database searches. We discuss these species below in section 5.2.1, with that discussion including some brief ecological information for each species and the reasons for their likelihood of occurrence in the survey area. More information is presented for those species recorded during the survey and or where there is substantial information (particularly ecological information) available in the literature.

5.2 Conservation Significant Fauna

During the 11 day survey, five species of conservation significance were recorded; one reptile, one bird and three mammal species:

- Black-lined Ctenotus (*Ctenotus nigrilineatus*) listed as Priority 1 under the WC Act;
- Rainbow Bee-eater (*Merops ornatus*) listed as Migratory under the EPBC Act and Schedule 4 under the WC Act;
- Northern Quoll (*Dasyurus hallucatus*) listed as Endangered under the EPBC Act and Schedule 1 under the WC Act;
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act; and
- Western Pebble-mouse (*Pseudomys chapmani*) listed as Priority 4 under DPaW.

The locations of conservation significant fauna observed during the field survey can be seen in Table 9 and Figure 6.

Table 9: Locations of conservation significant species

Conservation significant sightings	No. of Individuals	Conservation Listing	Location	Habitat
Black-lined Ctenotus	1	P1	Trap Site 2	Drainage Line
Black-lined Ctenotus	1	P1	Trap Site 3	Hill
Black-lined Ctenotus	3	P1	Trap Site 5	Drainage Line
Black-lined Ctenotus	4	P1	Trap Site 6	Hill
Rainbow Bee-eater	20	Migratory	Opportunistic	N/A
Northern Quoll	1	Endangered	Adit at 0199851/ 7577636	Drainage Line
Pilbara Leaf-nosed Bat	Numerous	Vulnerable	Adit at 0199991/ 7577674	Degraded Mining Area
Pilbara Leaf-nosed Bat	Numerous	Vulnerable	Adit at 0199851/ 7577636	Degraded Mining Area
Western Pebble-mouse	1	P4	Trap Site 4	Hill

5.2.1 Conservation Significant Species Recorded

Five conservation significant species were recorded during the field survey; the Black-lined Ctenotus, Rainbow Bee-eater, Northern Quoll, Pilbara Leaf-nosed Bat and Western Pebble-mouse.

Black-lined Ctenotus (*Ctenotus nigrilineatus*)

The Black-lined Ctenotus is listed as Priority 1 under the WC Act. It has dark-brown back and sides with eight pale longitudinal stripes at the mid-body, five dark dorsal stripes and its upper foreparts of the body are flushed pink (Cogger 2014).

Nine Black-lined Ctenotus were recorded at four trap sites across the survey area (Table 8 & Figure 6). There are 19 records from between 2006 and 2010 of the Black-lined Ctenotus in the DPaW threatened fauna database for the Nullagine area. During the survey this species was recorded in Hill and Drainage Line habitat. Given the extent of this habitat in the survey area and in the broader region, the 19 records in the DPaW database, this species is likely to be more common and widespread. As a result, activity and disturbance associated with mining in the survey area is unlikely to significantly impact this species at the local or regional scale.

Plate 12: Black-lined Ctenotus

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as migratory under the EPBC Act. This species is one of the most common and widespread birds in Australia with a distribution that covers the majority of Australia (Barrett *et al.* 2003). The Rainbow Bee-eater is a common and widespread species in WA, except the drier interior of the State and the far south-west. It occurs in lightly wooded, often sandy country, preferring areas near water. It feeds on airborne insects, and nests throughout its range in WA in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone & Storr 1998). In WA this bird can occur as a 'resident, breeding visitor, postnuptial nomad, passage migrant and winter visitor' (Johnstone & Storr 1998).

The Rainbow Bee-eater is a medium-sized bird, and the only species of bee-eater in Australia. The adults have green or blue-green colouring on the forehead and chestnut on the back of the head (Higgins 1999). There is a bold black stripe across the eye that is bordered below by a narrower blue stripe and bright yellow colouring on the chin and cheeks that changes to chestnut around the throat and that is bordered by a conspicuous, crescent-shaped black patch on the front of the neck. The upper part of the back is bright green, merging to light blue on the lower part of the back to the base of the tail. The tail is black with blue edging on the upper surface and two long, wire-like central feathers (termed streamers) that project beyond the tip of the tail. Rainbow Bee-eaters have a long, slender and decurved black bill, red iris, dark grey skin around the eye and blackish legs and feet (Higgins 1999).

During the survey approximately 20 individuals were opportunistically recorded flying over the survey area (see Table 8). There are 53 records in the DPaW threatened fauna database for the Nullagine area, with most records from between 2010-2012. The survey area provides suitable foraging habitat and an area of permanent water (the Dam) for the Rainbow Bee-eater. Given that the Rainbow Bee-eaters is one of Australia's most common and widespread birds, activity and disturbance associated with mining in the survey area is unlikely to significantly impact this species at the local or regional scale.

Plate 13: Rainbow Bee-eater

Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is listed as Endangered under the EPBC Act and S1 under the WC Act. The range of the Northern Quoll has contracted across northern Australia since European settlement, but its decline has accelerated since the arrival of the cane toad, and it now occurs as several disjunct populations (Braithwaite & Griffiths 1994; Van Dyck & Strahan 2008). The Northern Quoll is most commonly found in dissected rocky escarpments and Eucalypt woodlands, but occasionally in rainforest patches and on beaches where they utilise a variety of den sites, including rock crevices, tree hollows, logs and termite mounds (Van Dyck & Strahan 2008). It favours rocky areas, taking refuge in rock crevices, and utilises gullies and drainage lines. It is nocturnal and shelters during the day in tree hollows, hollow logs, termite mounds or rock piles, typically moving frequently amongst a set of den sites (Woinarski *et al.* 2014).

It is important to note that much of the ecological information for the Northern Quoll comes from studies in the Top End of the Northern Territory (e.g. Begg 1981; Oakwood 2002). Much of their ecology is likely to be similar in the Pilbara; however, differences in genetic structure and some demographic parameters have been observed (How *et al*. 2009).

The Northern Quoll has a relatively large home-range size of up to 150 ha for males (35 ha for females). Movements between den sites on consecutive nights can be up to 1.85 km for males (Oakwood 2002). In the Northern Territory, mating occurs in late May to June and all males die after the mating season and female's rear the young alone (Oakwood 2000). The young spend about two months in the pouch and are then left in a succession of nursery dens for the next three months for periods at night while the mother forages (Oakwood 2000). In the Kimberley, Schmitt *et al.* (1989) found that breeding occurred in July and August. However, at Woodstock Station in the Pilbara, breeding occurred in September, a month later than the Kimberley (How *et al.* 2009). This variation in time of breeding across three distinct populations indicates some reproductive flexibility in the species.

During the survey one Northern Quoll was recorded on a motion camera (Plate 11) in the survey area (Table 8 and Figure 6). There are 12 Northern Quoll records in the DPaW threatened fauna database for the Nullagine area, and 10 of these are since 2011. Habitat in the survey area appears to be at best marginal for the Northern Quoll, as there are relatively few if any suitable rock piles and rock outcropping for denning and none of the Drainage lines had trees with hollows large enough to be used as a den site. The motion camera that captured images of the Northern Quoll was placed on a Fig Tree (*Ficus brachypoda*) that was in front of an adit. There were also other adits in the immediate area, so perhaps the Northern Quoll was denning in one or several of these (though no scats were recorded).

A targeted Northern Quoll survey is planned to be undertaken in April 2015 and discussions have already taken place with DPaW regarding timing, methods to be used and survey effort. The survey will follow as closely as possible methods outlined in Dunlop *et al.* 2014.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

The Pilbara Leaf-nosed Bat (PLNB) is listed as Vulnerable under the EPBC Act and S1 under the WC Act. The PLNB is dependent on caves and mines with very hot and humid roost sites (28-32^{0}C and 96-100% humidity) during the dry season (Armstrong 2000; Churchill 2008). Caves and mines, which have these specific characteristics, are relatively uncommon in the Pilbara. Without these conditions, PLNB are susceptible to dehydration and hypothermia and can die within a few hours.

The PLNB is now known to be more widespread than previously supposed; however, most of its maternity roost sites are confined either to banded ironstone strata that may be mined or to underground mine adits that are now collapsing or being open cut (Woinarski *et al.* 2014).

During the survey calls of the PLNB were detected in low numbers on SM2 units at two locations (Table 8 and Figure 6). At both of these locations the SM2 units were placed in front of old adits (both appeared not to be deep or extensive). The DPaW threatened fauna database records show 16 observations of the PLNB in the Nullagine area since 2012.

A targeted PLNB survey was undertaken at the beginning of December 2014 by Bob Bullen (from Bat Call WA) and 360 Environmental (see Appendix H) for the complete report). During the targeted survey, PLNB activity was detected at many sites across a 20 km radius around the survey area. Timing of the calls detected indicates that there is a previously unknown diurnal, and possibly maternal roost in the Nullagine district. The exact location of the colony's roost was not found but the activity levels and temporal pattern of detections show that it is not within or immediately adjacent to the survey area. The results suggest that the roost lies in one of the ridges to the south of Beatons Creek outside of the areas currently being considered for mining.

Western Pebble-mouse (*Pseudomys chapmani*)

The Western Pebble-mouse is listed as Priority 4 by DPaW and is endemic to the Pilbara. This species builds pebble mounds that are built from small stones, which typically cover areas from 0.5-9.0 m^2, which are characteristic of this species. Pebble mounds are restricted to suitable-class stones, and are usually found on gentle slopes and spurs that are often vegetated by hard spinifex (Ford & Johnson 2007; Van Dyck & Strahan 2008). Active mounds are characterised by the conical shape of the mound with clear, distinct entrance holes (Anstee 1996).

Pebble mounds constructed by Western Pebble-mouse are found throughout the Pilbara however, studies have shown that not all mounds in an area are occupied by a Pebble-mouse at any one time (Anstee 1996).

One Western Pebble-mouse was captured in an Elliott trap at trap site 4 which is in Hill habitat (Table 8 and Figure 6) and disused Pebble-mouse mounds were found at two locations (Plate 14 and Figure 6). The DPaW threatened fauna database records show eight observations of the Western Pebble-mouse in the Nullagine area since 1993, with four after 2011.The survey area contains suitable habitat such as hills and slopes that are covered in small pebbles. This species is found broadly across much of the Pilbara (Gibson & McKenzie 2009); therefore any localised loss of habitat within the study area is unlikely to significantly impact this species overall conservation status.

Plate 14: Disused Western Pebble-mouse Mound

5.2.2 Species Considered as Likely to Occur

Seven species were considered as Likely to occur in the survey area; The Pilbara Olive Python, Eastern Great Egret, Australian Bustard, Oriental Plover, Sharp-tailed Sandpiper, Wood Sandpiper and Ghost Bat.

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python (Olive Python) is listed as Vulnerable under the EPBC Act and is classified as Schedule 1 under the WC Act. The Olive Python occurs in the ranges of the Pilbara, typically in escarpments and gorges where water is present (Pearson 1993 & 2003). This large python is threatened because it has a relatively small distribution, occurs in low population densities and may be affected by habitat disturbance such as grazing and fire. Although the home range of this species has not been intensively studied, radio tracking has shown that they have large home ranges of 87 - 449 ha, with males having larger home ranges than females (Tutt *et al.* 2004). This species is known to frequent water bodies where it ambushes prey (Pearson 1993). During the systematic survey of a large series of quadrats in the Pilbara, the Olive Python was only recorded in one quadrat (Doughty *et al.* 2011). This species is extremely difficult to detect and as a consequence difficult to survey for, particularly as a result of its cryptic nature (primarily nocturnal and a sit and wait predator).The Olive Python shelters under rock piles, or under spinifex and often basks on top of rocks (Tutt *et al*. 2004).

There is one record of the Olive Python in the DPaW threatened fauna database in the Nullagine area from 2011. The Olive Python was not recorded during the survey, however, there were some minor gorges that contained some water during the survey (though very limited) that may be suitable as ambush sites. And the Dam (permanent water) is also present in the north eastern section of the survey area and this is also likely to be suitable habitat. As such the Olive Python is considered as Likely to occur in the survey area.

Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret is listed as migratory under the EPBC Act. It occurs in the Kimberley, Pilbara, and on the west coast from the Murchison River south, throughout the south-west, and east to Cape Arid (Johnstone & Storr 1998). In the Pilbara this species is an uncommon to very common visitor, usually in ones, twos or small flocks, occasionally in very large aggregations (up to 1,200), e.g. in Mandora Marsh in Oct. 1999 and June 2000 and Fortescue Marsh in June 2000 (Johnstone *et al.* 2013). In the Pilbara it is typically found in flooded claypans, flooded samphire (inundated by rain or high tides), river pools, sewage ponds, mangrove creeks and saltwork ponds (Johnstone *et al.* 2013).

There are five records since 2003 of the Eastern Great Egret in the DPaW threatened fauna database for the Nullagine area. Some of the larger drainage lines in the survey area may provide foraging habitat for this species, particularly when there is pooling water, and the permanent water associated with the Dam is also likely to provide foraging habitat for this species. Consequently the Eastern Great Egret is considered as Likely to occur in the survey area.

Australian Bustard (*Ardeotis australis*)

This species is listed as Priority 4 under the DPaW priority list. The Australian Bustard is a large highly-mobile mostly nomadic bird that occurs widely over the majority of northern and central Australia with a preference for open habitats, ranging from open grassland plains to low shrublands and grassy open woodlands (Barrett *et al.* 2003; Ziembicki 2010). The Australian Bustard is known to be most abundant in the Pilbara and the savannas of northern Australia (Ziembicki & Woinarski 2007).

The abundance of this species varies according to habitat and season, in particular the abundance of grasshoppers. It is a highly mobile species, which appears to be irruptive in relation to rainfall patterns and bushfires (Ziembicki 2010).

There are 12 records of the Australian Bustard in the DPaW threatened fauna database for the Nullagine area, with eight records since 2010. The majority of the survey area contains suitable foraging habitat for this species. Therefore the Australian Bustard is considered as Likely to occur in the survey area.

Sharp-tailed Sandpiper (*Calidris acuminata*)

The Sharp-tailed Sandpiper is listed as Migratory and Marine, under the EPBC Act. Its habitat includes tidal flats, beaches, saltmarshes, mangroves, shallow fresh, brackish or saline inland wetlands (river pools); floodwaters, irrigated pastures and crops. The Sharp-tailed Sandpiper breeds in Siberia and is a widespread summer migrant to coastal and inland Australia (Barrett *et al.* 2003)).

Most of the records for this species in the Pilbara come from Port Hedland, and it is much less common but widespread inland with most records associated with areas of temporary flooding (e.g. after cyclonic rains) (Johnstone *et al.* 2013). There are no over-wintering records of this species for the Pilbara (Johnstone *et al.* 2013). There is one record in the DPaW threatened fauna database from the Nullagine Lagoon at the end of October 2010.

The Dam has permanent water and is likely to provide suitable foraging habitat for this species. As such that the Sharp-tailed Sandpiper is considered as Likely to occur in the survey area.

Wood Sandpiper (*Tringa glareola*)

Listed as Migratory and Marine under the EPBC Act, the Wood Sandpiper is a nervous, dainty wader found mostly in shallow fresh waters, often among dead timber, along muddy margins or wetlands, tidal mangroves and saltmarshes.

It is a summer visitor (August to April) from the northern hemisphere. In the Pilbara it is probably essentially a passage migrant with peak numbers along Port Hedland-Shay Gap area in September, after which several locations in that area are less commonly utilised (Johnstone *et al.* 2013). It is recorded uncommonly in ones, twos or small flocks (up to 30). It is mostly seen in river pools, sewage ponds, flooded claypans, freshwater lagoons and bore overflows (Johnstone *et al.* 2013).

There are two records of the Wood Sandpiper in the DPaW threatened fauna database, both are from 2010 and one is from the Nullagine Lagoon (which is on the Nullagine River at the eastern end of the Nullagine Township). The Dam may be suitable habitat for this species, and given the relatively recent records of this species from the Nullagine Lagoon we consider it as Likely to occur in the survey area.

Ghost Bat (*Macroderma gigas*)

The Ghost Bat is listed as Priority 4 under the DPaW priority list. In the Pilbara region the preferred habitat (natural habitat) of the Ghost Bat in the Hamersley Ranges is in caves beneath bluffs of low rounded hills composed of Marra Mamba geology. Ghost Bats have also been found in the larger hills of Brockman Iron Formation in the Hamersley Range, and other formations beneath bluffs composed of Gorge Creek Group geology to the north east (Armstrong & Anstee 2000). Granite rockpiles are also used in the eastern Pilbara, as well as limited habitat from natural cave formations in the region. A number of natural formations are utilised in the Pilbara; some formations are used intermittently as short-term transient roosts and for feeding activity for single or small numbers of individuals, and others are used by maternity colonies (Armstrong & Anstee 2000). Maternity roosts also occur in gold/copper mines that are now collapsing or being cut open, and caves in banded ironstone strata that may be mined out over the next 30-50 years. On current trends, most of the known Ghost Bat Pilbara sites may be destroyed over the next 30 years (Woinarski *et al.* 2014).

However, between 2004 and 2007 a systematic survey of micro bats was undertaken across the Pilbara region that included the recording of echolocation calls at 69 sites dispersed among 24 survey areas covering the 179,000 km^2 region (McKenzie & Bullen 2009). McKenzie & Bullen (2009) suggest that it is more common than previously thought, occurring in 21 of the 24 areas they surveyed, and in all 4 sub-regions of the Pilbara. They detected its calls at new sites in 10 of the 24 survey areas despite the sparsity of the sampling and the low intensity of Ghost Bat calls (bat detector range is < 3 m for the Ghost Bat) (McKenzie & Bullen 2009).

The DPaW threatened fauna database shows 28 records of the Ghost Bat in the Nullagine area. Of these 28 records, 18 were historical; however, nine were since 2006. Ghost Bats were not recorded on the SM2 units during the survey and this was partly expected, as they are primarily a 'sit and wait' predator (Tidemann *et al.* 1985), consequently echolocation is not often used while they forage.

The survey area contains suitable foraging habitat and is in the species' known distribution and there are many records in the Nullagine area. The species is therefore considered as Likely to occur in the survey area.

5.2.3 Species Considered as Possibly Occurring

Five species were considered as possibly occurring, the Grey Falcon, Peregrine Falcon, Bush Stone-curlew, Australian Painted Snipe and the Barking Owl.

Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is listed as Schedule 1 under the WC Act. It is a poorly known endemic of inland Australia and is considered Australia's rarest falcon. It is also among the rarest Falco species in the world (Schoenjahn 2012).

The species is a resident or nomadic visitor to inland parts of all states (except Tasmania) from a range of habitats but are mainly found where annual rainfall is <500 mm, except when wet years are followed by drought and then they are more widespread (Garnett *et al.* 2011). Nesting has been recorded from River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*) trees up to 15 m above the ground (Johnstone & Storr 1998; Garnett *et al.* 2011).

The DPaW threatened fauna database has two observations of the Grey Falcon in the Nullagine area, both from the 1990's. Bamford Consulting Ecologists (2013) recorded one Grey Falcon in 2012 along a wooded creek line about 20 km south-west of Nullagine.

The survey area lacks lacks large trees suitable for nesting but it could forage across the site. Therefore the Grey Falcon is considered as Possibly occurring in the survey area.

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed as Schedule 4 under the WC Act and is an uncommon but wide-ranging bird across Australia (Barrett *et al.* 2003). It occurs mainly along rivers and ranges as well as wooded watercourses and lakes and nests primarily on cliffs, granite outcrops and quarries. The diet of the Peregrine Falcon has been well studied and primarily includes flocking species such as Parrots, Pigeons and on the east coast European Starlings (Olsen & Fuentes 2008).

The DPaW threatened fauna database has two records of the Peregrine Falcon in the Nullagine area, both from 2006 and 2011.

The survey area lacks suitable river and cliff habitat and while the species may utilise the survey area as a part of a larger foraging area, it lacks any suitable nesting habitat. The Peregrine Falcon is therefore considered as Possibly occurring in the survey area.

Bush Stone-curlew (*Burhinus grallarius*)

The Bush Stone-curlew listed as Priority 4, occurs across much of Australia and inhabits a broad range of habitats including dry open woodlands, but may prefer habitat near drainage lines or wetlands and lightly wooded country near adequate daytime shelter (Geering *et al.* 2007; Johnstone *et al.* 2013). In the areas where the fox occurs the Bush Stone-curlews population has been reduced and it is now locally extinct in the southern section of Western Australia (Johnstone & Storr 1998). However, the northern populations of this species have remained largely intact with no suggestion of decline (Garnett *et al.* 2011).

The DPaW threatened fauna database has five records of the Bush Stone-curlew in the Nullagine area, since 2006, four of which are between 2012 and 2013. The survey area does have some suitable habitat along some of the larger drainage lines, though limited. As such the Bush Stone-curlew is considered as Possibly occurring in the survey area.

Australian Painted Snipe (*Rostratula australis*)

The Australian Painted Snipe (Painted Snipe) is listed as Endangered under the EPBC Act. It inhabits shallow, vegetated, temporary or infrequently filled inland wetlands of Australia. Numbers of the Painted Snipe are thought to have declined substantially since European settlement, particularly over the last 50 years due to the loss and alteration of wetlands (Garnett *et al.* 2011).

Migration patterns of the Painted Snipe are poorly known (Pringle 1987), although the species is believed to disperse widely as evidenced by irregular and infrequent occurrences and breeding throughout Australia (Marchant & Higgins 1993). Movements have been attributed to local conditions: birds move to flooded areas; from drying to permanent wetlands; away from areas affected by drought.

The Painted Snipe is a rare irregular summer visitor mainly to southern wetlands. Recorded at limited locations throughout the Pilbara, including a Paraburdoo sewage pond in 1974, at an artificial pond at Rhodes Ridge Exploration Camp (50 km WNW of Newman) in 1987, one in flooded samphire at Mandora Marsh area in 1999, a pair at Western Creek crossing in 2011 a female photographed at Rangers HQ, Karijini National Park in 2012 (Johnstone *et al.* 2013) and a single famale at Coondiner Pool, 70 km from Newman (Knuckey *et al*. 2013).

There are no records of the Painted Snipe in the DPaW threatened fauna database in the Nullagine area.

The Dam habitat provide suitable foraging habitat, however a lack of reeds around the dam results in limited nesting habitat for the Painted Snipe. As a result the Painted Snipe is considered as Possibly occurring in the survey area.

Barking Owl (*Ninox connivens*)

The Barking Owl is listed as Priority 2 under the DPaW priority list. It is found throughout the Pilbara region, north to Mandora, south to lower Ashburton River and east to Davis River and Weeli Wolli Spring. It is uncommon, and usually found in pairs. It favours dense waterside forests of *Melaleuca argentea* and *E. camaldulensis* (Johnstone *et al.* 2013).

The DPaW database has one record of the Barking Owl in the Nullagine area in 2005. The survey area lacks suitable roosting habitat (though it could forage in the survey area), but there is roosting habitat outside of the survey area (but nearby), particularly along the Nullagine River. Consequently the Barking Owl is considered as Possibly occurring in the survey area.

5.2.4 Species Considered as Unlikely to Occur

Ten species of conservation significance are considered Unlikely to occur in the survey area; the Fork-tailed Swift, Cattle Egret, White-bellied Sea-eagle, Night Parrot, Princess Parrot, Striated Grasswren, Brush-tailed Mulgara, Long-tailed Dunnart, Bilby and the Northern Marsupial Mole.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed as migratory under the EPBC Act and as S4 under the WC Act. It is a non-breeding visitor to all states and territories of Australia (Higgins 1999). The Fork-tailed Swift is a summer migrant to Australia usually during the months of October-April. The Fork-tailed Swift is an aerial species which forages high above the tree canopy and is independent of terrestrial habitats. It occurs in flocks of up to 2,000 birds and is often seen accompanying Tree Martins and Masked Wood swallows (Johnstone & Storr 1998). In the Pilbara, however, they are considered to be uncommon to moderately common, and usually appear ahead of cyclones or during thunderstorms (Johnstone *et al.* 2013).

There are no records of the Fork-tailed Swift in the DPaW threatened fauna database for the Nullagine area. However, it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the Fork-tailed Swift.

Consequently, it will not be reliant on habitats of the survey area but could possibly fly above. As such the Fork-tailed Swift is considered as Unlikely to occur in the survey area.

Cattle Egret (*Ardea ibis*)

The Cattle Egret is listed as Migratory Marine under the EPBC Act. It occurs in the wetter parts of WA, in particular the Kimberley and the south-west. The species inhabits short grass, especially damp pastures and wetlands, usually in the company of cattle and occasionally other livestock. In WA it is an irregular visitor, occurring mostly in autumn, and is not thought to breed regularly (Johnstone & Storr 1998).

In the Pilbara it is a very rare visitor, having been recorded at only five sites and in very low numbers (one or two birds) (Johnstone *et al.* 2013). There are no records of the Cattle Egret in the DPaW threatened fauna database for the Nullagine area, but was present in the EPBC protected matters report, which as noted in section 5.1 is not entirely based on point records, but also on broader information, for example bioclimatic distribution models. Whereas DPaWs NatureMap and threatened fauna database is based on point records, consequently, the results of the EPBC Protected Matters Search Tool are in some cases less accurate, particularly at a local scale.

The Dam area might be considered suitable habitat, but given the lack of records for this species in the Pilbara, the Cattle Egret is considered as Unlikely to occur in the survey area.

Oriental Plover (*Charadrius veredus*)

The Oriental Plover is listed as Migratory and Marine under the EPBC Act. This species is a common summer visitor from northern hemisphere (late August to early April) and it occurs mainly on the coastal plains and does not overwinter in the Pilbara (Johnstone *et al.* 2013).

The Oriental Plover breeds in Mongolia, Siberia and China, wintering mainly in northern Australia (Pizzey & Knight 1999).

There were no records of the Oriental Plover in the DPaW threatened fauna database for the Nullagine area, but it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the Oriental Plover.

It mainly occurs in coastal samphire and grass flats, also beaches, tidal creeks, saltwork ponds and sewage ponds as far inland as Newman (Johnstone *et al.* 2013). The Dam area might be considered suitable habitat, but given the lack of records for this species in the Pilbara, the Oriental Plover is considered as Unlikely to occur in the survey area.

White-bellied Sea-eagle (*Haliaeetus leucogaster*)

The White-bellied Sea-eagle is listed as Migratory and Marine under the EPBC Act and as Schedule 3 under the WC Act. It inhabits most coasts and other near-coastal wetlands. It is found casually on Pilbara rivers and is moderately common to common on Pilbara islands (Johnstone *et al.* 2013). It breeds almost wholly on islands and feeds mainly on fish, sea snakes and nesting seabirds (Johnstone & Storr 1998).

The DPaW threatened fauna database had no records of the White-bellied Sea-eagle in the Nullagine area. However, it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the White-bellied Sea-eagle.

The Dam in the survey area may possibly contain limited suitable habitat and prey items, though this is doubtful. As such the White-bellied Sea-eagle is considered as Unlikely to occur in the survey area.

Night Parrot (*Pezoporus occidentalis*)

The Night Parrot is listed as Vulnerable under the EPBC Act. It is an enigmatic species thought possibly to be extinct until the recent recoveries of two dead specimens from Queensland. The type specimen and many early sightings, however, came from W A (Johnstone *et al.* 2013). A more recent sighting of the Night Parrot was on 12 April 2005, at a well near the Fortescue Marshes (Davis & Metcalf 2008). The DPaW threatened fauna database has no records of the Night Parrot in the Nullagine area. However, it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the Night Parrot.

The survey area contains limited suitable habitat and as such the Night Parrot is considered as Unlikely to occur in the survey area.

Princess Parrot (*Polytelis alexandrae*)

The Princess Parrot is listed as Vulnerable under the EPBC Act and as Priority 4 under the DPaW priority list. The Princess Parrot is confined to arid regions of WA, the Northern Territory, and South Australia (Barrett *et al.* 2003). Preferred habitat includes lightly wooded country of *Casuarina decaisneana.* The species is usually recorded from shrublands and savannah woodlands in swales between sand dunes consisting of open mallee-spinifex *(Eucalyptus* and *Triodia*) and open marble gum woodland (*E. gongylo*carpa) and a variety of shrubs and scattered emergent trees (Garnett *et al*. 2011).

The DPaW threatened fauna database has no records of the Princess Parrot in the Nullagine area. However, it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the Princess Parrot.

The survey area contains no suitable habitat in the form of shrublands and savannah woodlands in swales between sand dunes. As such the Princess Parrot is considered as Unlikely to occur in the survey area.

Striated Grasswren (subspecies *Striatus*)

This Striated Grasswren (subspecies *Amytornis striatus striatus*) which is a Priority 4 species came up in the NatureMap search, however, this is an error as it does not occur in the Pilbara. The subspecies that occurs in the Pilbara is *Amytornis striatus whitei* (Johnstone *et al.* 2013). Consequently this species will not occur in the survey area.

Brush-tailed Mulgara (*Dasycercus blythi*)

The Brush-tailed Mulgara (Mulgara) is listed as Priority 4 under the DPaW priority list. It inhabits spinifex grasslands in central Australia and lives in burrows that it digs on the flats between low sand dunes (Van Dyck & Strahan 2008). The Mulgara appears to use defined home ranges, which overlapped extensively with those of several neighbours. Spatial overlap occurs between as well as within sexes. Home ranges and burrows encompass both mature spinifex and open regrowth (Kortner *et al*. 2007).

The DPaW threatened fauna database has two records of the Mulgara in 2010 in the Nullagine area. These two records come from surveys undertaken in sandy soil areas at the Barton Mine which is approximately 20 km to the east of Nullagine (Ninox Wildlife Consulting 2011).

The survey area lacks suitable sand dune habitat for the Mulgara, therefore it is considered Unlikely to occur in the survey area.

Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Long-tailed Dunnart is listed as Priority 4 under the DPaW priority list. Records of the Long-tailed Dunnart come from widely scattered localities in the arid zone where it inhabits rugged, rocky areas. Little is known of the life history of long-tailed dunnarts, but available evidence suggests that this widely scattered species is restricted to rugged, rocky areas (Burbidge *et al*. 2008).

Habitat includes plateaus composed of boulders and stones, with fine red sand sparsely vegetated with Mulga and Miniritchie shrubs over Spinifex and areas of open woodland of Mulga (Van Dyck & Strahan 2008). The striated foot-pad and long strongly muscular tail of the Long-tailed Dunnart suggest it is an active and capable climber.

The DPaW threatened fauna database has one record of the Long-tailed Dunnart from 2005. This record comes from 21 km west-north-west of Bonney Downs Homestead.

The survey area does not contain rocky rugged areas an amount of suitable habitat, such as rocky outcrops however, the Long-tailed Dunnart is therefore considered as Unlikely to occur in the survey area.

Bilby (*Macrotis lagotis*)

The Bilby is listed as Vulnerable under the EPBC Act and as S1 under the WC Act. Before European settlement the Bilby was found on over 70% of the Australian mainland; the species now only occurs in less than 20% of its former range (Southgate 1990). Wild Bilby populations are now restricted predominantly to the Tanami Desert, Northern Territory (Johnson & Southgate 1990), the Great Sandy and Gibson Deserts in WA (Friend 1990), and an outlying population between Boulia and Birdsville in south-west Queensland (Gordon *et al.* 1990).

Extant populations of the Bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (typically sandy for burrow excavation). It occupies three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990). Laterite and rock feature substrates are an important part of Greater Bilby habitat, which support shrub species such as Acacia, and Spinifex hummocks which are quite uniform and discrete, providing runways between hummocks, enabling easier movement and foraging (Southgate *et al.* 2007).

The DPaW threatened fauna database has five records of the Bilby in the Nullagine area since 2010. In 2010, Bilby tracks were recorded in sandy areas at the Barton Mine which is approximately 20 km to the east of Nullagine (Ninox Wildlife Consulting 2011). The survey area has very few to no areas where the Bilby could possibly construct burrows (the survey area consists primarily of stony and rocky hills); therefore the Bilby is considered Unlikely to occur in the survey area.

Northern Marsupial Mole (*Notoryctes caurinus*)

The Northern Marsupial Mole (Mole) is listed Endangered under the EPBC Act and as Schedule 1 under the WC Act. It occurs in the sand-dune deserts of north-western Australia, particularly the Great Sandy and Little Sandy Deserts (Van Dyck & Strahan 2008). The Northern Marsupial Mole lives underground, primarily in sand dunes and sandy soils along river flats. It occasionally comes to the surface, apparently more frequently after rain. Vegetation in Mole habitat is generally *Acacia spp*., small shrubs and Desert Oak (*Allocasuarina decaisneana*) and often (but not always) associated with spinifex (*Triodia spp.*). Sandy river flats are also thought to be potential Northern Marsupial Mole habitat, as they are rich in food resources and may act as dispersal corridors (Benshemesh 2004).

The DPaW threatened fauna database had no records of Mole in the Nullagine area. However, it was present in the EPBC protected matters report. Please see section 5.1 above as to the reasons why this is not always an accurate reflection of what species may occur in an area, as is the case with the Mole.

The survey area does not contain suitable habitat in the form of sand dunes, therefore the Mole is considered Unlikely to occur in the survey area.

5.3 Fauna Habitat Types

Four habitat types were identified in the survey area; Hill, Degraded Mining Area, Drainage Line, Dam and were present in the survey area. These habitats were considered to range from Very Degraded (historical and current mining areas [including exploration areas]) to Pristine condition in Hill habitat. These habitats are widespread and common in the Pilbara region.

5.3.1 Hill

This habitat type was characterised by rocky hill slopes and ridges and was the most widespread habitat in the survey area. The vegetation was a sparse mix with an overstorey of *E. leucophloia* and *Corymbia hamersleyana*, a midstorey of *Acacia spp.* (when present) and a moderate ground cover of *Triodia spp*. There is generally a low diversity of microhabitats with few logs and woody debris, and few tree hollows. The soil is hard and unsuitable for burrowing fauna.

The hard rock surface and some smaller areas of outcropping and rock piles that contain some small crevices, do occur in this habitat, providing suitable refuge for saxicoline reptiles and some small mammals such as the Pilbara Ningaui. It was in Hill habitat that the Western Pebble-mouse was trapped and where disused Pebble-mouse mounds were located.

Fauna of conservation significance that was recorded in this habitat included the Northern Quoll, PLNB, Western Pebble-mouse, and Rainbow Bee-eater.

5.3.2 Degraded Mining Area

A large part of the southern region of the survey area has been subjected to historical mining activities. Large sections have been cleared entirely and so are completed degraded. Some areas still have small amounts of vegetation, particularly on the top of hills, mainly Triodia sp. This limited vegetation still provides some habitat for common bird species such as skinks.

5.3.3 Drainage Line (including mirror gorge habitat)

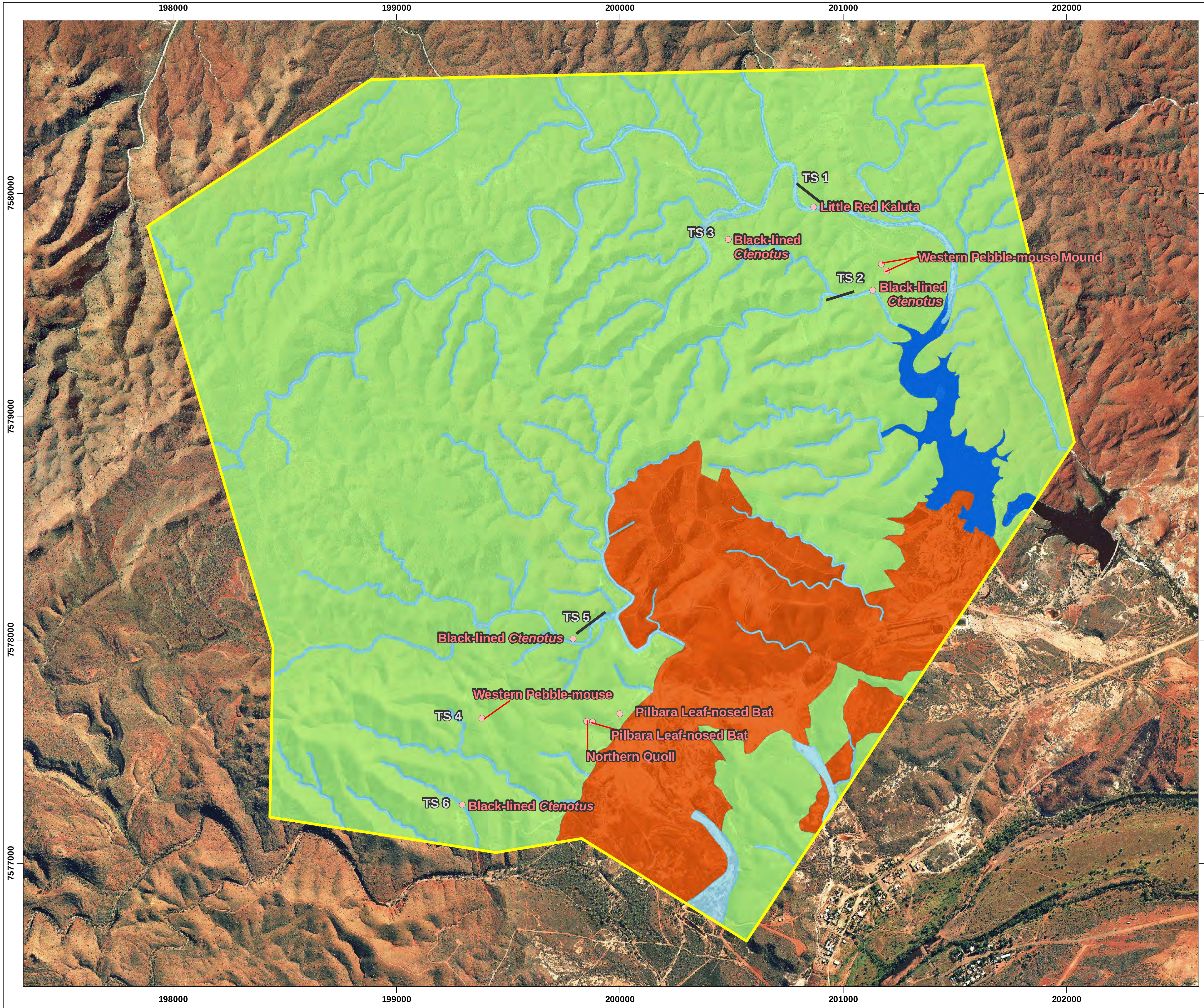
Lower drainage line habitat in the survey area is characterised by soft, red-brown sandy-loam soils, with a mix of *E. leucophloia* and *Melaleuca glomerata* trees. These trees offer a relatively wide range of microhabitats (relatively larger and denser tree canopies, some small hollows [though limited], bark, and branches) and moister and shadier conditions, occasionally with free-standing water. The softer soils are suitable for burrowing fauna species such as *P. desertor* and *Ramphotyphlops grypus*.

Upper drainage line habitat is more incised and forms minor gorge habitat with steeper cliff sides, bare rock floor and large boulders. *Acacia spp.* provide habitat for species such as Painted Finches, while caves (though limited) provide habitat for various bat species (potentially including the PLNB). Small pools of semi-permanent water provide drinking opportunities for birds and mammals, especially macropods and micro bats, and potential breeding sites for amphibians (noting that none were recorded in the survey area during the survey).

Fauna of conservation significance likely to use Drainage habitat include the Northern Quoll and PLNB. The mature Eucalypt trees in this habitat are larger than trees in the surrounding hills; therefore this habitat may act as a wildlife corridor. In particular, birds, bats, large mammals (such as the Euro) and reptiles (such as snakes and goannas) are likely to use the drainage line as a wildlife corridor. They may also use this habitat if large hollows are present which are suitable for denning.

5.3.4 Dam

Free standing and permanent water at the man-made dam in the east of the survey area provides drinking opportunities for mammals, especially macropods and micro bats (potentially the PLNB), as well as a variety of passerines such as White-plumed Honeyeater, water birds such as Pied and Little Cormorants, and birds of prey such as Black and Whistling Kites. The permanent water source is also a potential breeding sites for amphibians, though none were recorded during the survey.



Legend

- Survey Area
- Trap Sites
- Conservation Significant Species
- Transects

Fauna Habitat

- Hill
- Degraded Mining Area
- Drainage Area
- Dam

- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

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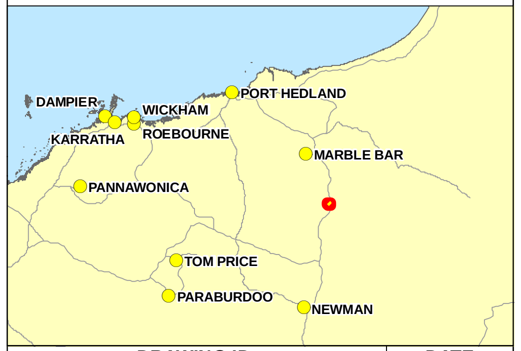
LOCALITY MAP



DRAWING ID	DATE
684_f4_consig.mxd	10-Feb-2015

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

CREATED	CHECKED	APPROVED	REVISION
CS	LS/RF	RF/FJ	0

Novo Resources
Beatons Creek, Nullagine

Baseline Vertebrate Fauna Survey

Figure 6
Conservation Significant Species

K:\Projects\1.0 EBS\684 Beatons Creek Fauna\Figures

6 Conclusion and Recommendations

6.1 Conclusion

Database searches (DPaW, EPBC Act Protected Matters Search Tool and NatureMap) returned 259 vertebrate species. Of these, eight were amphibians, 85 were reptiles, 120 were bird species and 46 were mammals.

A total of 27 conservation significant fauna species (including Priority species) were identified during the desktop review of the database searches. Two were reptiles, were birds and eight were mammals.

During the field survey, 65 species were recorded. These comprised of 22 species of reptile, 29 bird species and 14 mammal species (including micro bats).

Five species of conservation significance were directly recorded during the field survey, the Black-lined Ctenotus which is listed as Priority 1 under the WC Act, the Rainbow Bee-eater, which is listed as Migratory under the EPBC Act and Schedule 4 under the WC Act, the Western Pebble-mouse, which is listed as Priority 4 by DPaW. Calls of the Pilbara Leaf-nosed bat were recorded and this species is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act and the Northern Quoll which is listed as Endangered under the EPBC Act and Schedule 1 under the WC Act was captured on a motion camera.

Four fauna habitats were identified in the survey area and these included Drainage Line, Hill, Dam and Degraded Mining Area. Habitat condition throughout the survey area ranged from Completely Degraded to Pristine. Drainage Line comprised 5.03% of the survey area, Hill habitat included 78.51% of the survey area, Dam comprised 1.56% and Degraded Mining Area included 14.90% of the survey area.

Given the extent of these habitats in the survey area (particularly Drainage Line and Hill habitat) and especially in the broader region, activity and disturbance associated with mining is unlikely to significantly impact on fauna in the survey area, but most certainly not at a regional scale.

6.2 Recommendations

In order to minimise the impact on vertebrate fauna, several general recommendations are provided below and these apply to exploration and mining activities:

- It is essential that all exploration drill holes are located and capped or plugged with reference to all safety procedures for drilling personnel;
- Avoid unnecessary clearing of vegetation beyond that strictly required;

- Windrows of topsoil, woody debris (this includes logs) and leaf litter formed during clearing should be retained, as they create good microhabitat for a large array of fauna, particularly reptiles;
- Rehabilitation of cleared areas such as laydown sites, access tracks and grid lines where these are no longer required; and
- Adequate rubbish disposal should be applied, especially for food refuse, in order to discourage scavenging by animals such as crows and feral cats. These animals can have an adverse impact on native fauna.

7 Acknowledgements

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APPENDIX A

Definition of Declared Rare / Priority / Threatened Fauna Species

Western Australian Threatened Fauna Categories Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

Department of Parks and Wildlife Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Categories of Threatened Fauna Species under the EPBC Act

Conservation Code	Description
Ex	Extinct Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.

E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Source: *Environment Protection and Biodiversity Conservation Act 1999*

APPENDIX B

Fauna Inventory

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DPaW = Department of Parks and Wildlife Priority Code, A = Listed in Naturemap, B= DPaW Threatened and Priority fauna search, C = EPBC Protected Matters search, D= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

AMPHIBIANS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
LIMNODYNASTIDAE								
Platyplectrum spenceri	Centralian Burrowing Frog				X			
MYOBATRACHIDAE								
Pseudophryne douglasi	Gorge Toadlet				X			
Uperoleia glandulosa	Glandular Toadlet				X			
Uperoleia russelli	Northwest Toadlet				X			
Uperoleia saxatilis	Pilbara Toadlet				X			
HYLIDAE								
Cyclorana maini	Sheep Frog				X			
Cyclorana platycephala	Water-holding Frog				X			
Litoria rubella	Dester Tree Frog				X			

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DPaW = Department of Parks and Wildlife Priority Code, A = Listed in Naturemap, B= DPaW Threatened and Priority fauna search, C = EPBC Protected Matters search, D= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

REPTILES		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
DIPLODACTYLIDAE								
Crenadactylus ocellatus	Clawless Gecko				X			
Diplodactylus conspicillatus	Fat-tailed Gecko				X			
Diplodactylus pulcher	Fine-faced Gecko							X
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko				X			X
Lucasium stenodactylum	Pale-snouted Ground Gecko				X			
Lucasium wombeyi	Wombeys Ground Gecko				X			X
Oedura marmorata	Marbled Velvet Gecko				X			
Rhynchoedura ornata	Western Beaked Gecko				X			
Strophurus elderi					X			
GEKKONIDAE								
Gehyra pilbara					X			X
Gehyra punctata	Spotted Rock Dtella				X			
Gehyra purpurascens					X			
Gehyra variagata	Tree Dtella				X			X
Heteronotia binoei	Bynoe's Gecko				X			X
Heteronotia spelea	Desert Cave Gecko				X			X
PYGOPODIDAE								
Delma elegans	Pilbara Delma				X			X
Delma nasuta					X			
Delma pax	Peace Delma				X			X
Delma tincta					X			
Lialis burtonis					X			
SCINCIDAE								
Carlia munda	Shaded-litter Rainbow Skink				X			X
Cryptoblepharus ustulatus					X			
Ctenotus duricola					X			
Ctenotus grandis subsp. Grandis					X			

REPTILES		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Ctenotus grandis subsp. Titan					X			
Ctenotus hanloni					X			
Ctenotus helenae					X			
Ctenotus leonhardii					X			
Ctenotus nigrilineatus	Black Lined Ctenotus		P1		X	X		X
Ctenotus pantherinus	Leopard Ctenotus				X			X
Ctenotus piankai					X			
Ctenotus rubicundus					X			
Ctenotus rutilans					X			
Ctenotus saxatilis	Stony-soil Ctenotus				X			X
Ctenotus schombergkii					X			
Cyclodomorphus melanops	Slender Blue-tongue				X			
Egernia cygnitos	Western Pilbara Spiny-tailed Skink				X			
Egernia formosa					X			
Egernia pilbarensis	Pilbara Skink				X			
Glaphyromorphus sp.					X			
Lerista bipes					X			
Lerista flammicauda					X			
Lerista jacksoni					X			
Lerista muelleri					X			
Lerista verhmens					X			
Menetia greyii	Common Dwarf Skink				X			
Menetia surda subsp. Surda					X			
Morethia ruficauda	Fire-tailed Skink				X			X
Notoscincus ornatus					X			
Proablepharus reginae					X			
Tiliqua multifasciata	Central Blue-tongue				X			
Tiliqua occipitalis	Western Bluetongue				X			
AGAMIDAE								
Amphibolurus gilberti	Gilbert's Dragon				X			
Amphibolurus longirostris	Long-nosed Dragon				X			
Ctenophorus caudicinctus caudicinctus	Ring-tailed Rock Dragon				X			X
Ctenophorus isolepis	Military Sand Dragon				X			
Ctenophorus nuchali	Central Netted Dragon				X			
Diporiphora valens	Pilbara Two-lined Dragon							X
Pogona minor subsp.minor	Dwarf Bearded Dragon				X			

REPTILES		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
VARANIDAE								
Varanus acanthurus	Spiny-tailed Monitor				X			X
Varanus brevicauda	Short-tailed Pygmy Monitor				X			
Varanus caudolineatus	Stripe-tailed Monitor				X			X
Varanus eremius	Pygmy Desert Monitor				X			
Varanus giganteus	Perentie				X			X
Varanus gouldii	Sand Monitor				X			
Varanus panoptes	Yellow-spotted Monitor				X			
Varanus pilbarensis	Pilbara Rock Monitor				X			
Varanus tristis	Racehorse Monitor				X			
TYPHLOPIDAE								
Ramphotyphlops ammoydytes	Brahminy Blind Sanke				X			
Ramphotyphlops grypus					X			X
Ramphotyphlops hamatus					X			
Ramphotyphlops pilbarensis					X			
BOIDAE								
Antaresia perthensis	Pygmy Python				X			
Antaresia stimsoni	Stimson's Python				X			
Aspidites melanocephalus	Black-headed Python				X			
Liasis olivaceus	Olive Python				X			
Liasis olivaceus barroni	Pilbara Olive Python	Vu			X	X	X	
ELAPIDAE								
Acanthophis wellsi	Pilbara Death Adder				X			X
Brachyurophis approximans	North-western Shovel-nosed Snake				X			
Demansia psammophis	Yellow-faced Whipsnake				X			
Demansia rufescens	Rufous Whipsnake				X			
Furina ornata	Moon Snake				X			
Pseudechis australis	Mulga Snake				X			X
Pseudonaja mengdeni	Western Brown Snake				X			
Pseudonaja modesta	Ringed Brown Snake				X			
Pseudonaja nuchalis	Gwardar, Northern Brown Snake				X			
Suta fasciata	Rosen's Snake				X			
Suta punctata	Spotted Snake				X			

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DPaW = Department of Parks and Wildlife Priority Code, A = Listed in Naturemap, B= DPaW Threatened and Priority fauna search, C= EPBC Protected Matters search, D= Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
CASUARIIDAE								
Dromaius novaehollandiae	Emu				X			
PHASIANIDAE								
Coturnix ypsilophora	Brown Quail				X			
PODICIPEDIDAE								
Poliocephalus poliocephalus	Hoary-headed Grebe				X			
Tachybaptus novaehollandiae	Australasian Grebe				X			
ANATIDAE								
Anas gracilis	Grey Teal				X			
Anas superciliosa	Pacific Black Duck				X			X
Aythya australis	Hardhead				X			
Chenonetta jubata	Australian Wood Duck				X			
Cygnus atratus	Black Swan				X			X
Dendrocygna eytoni	Plumed Whistling Duck				X			
COLUMBIDAE								
Columba livia	Rock Pigeon						X	
Geopelia cuneata	Diamond Dove				X			X
Geopelia striata	Peaceful Dove				X			
Geophaps plumifera	Spinifex Pigeon				X			X
Ocyphaps lophotes	Crested Pigeon				X			X
Phaps chalcoptera	Common Bronzewing				X			
AEGOTHELIDAE								
Aegotheles cristatus	Australian Owlet-nightjar				X			
CAPRIMULGIDAE								
Eurostopodus argus	Spotted Nightjar				X			X
APODIDAE								
Apus pacificus	Fork-tailed Swift	MiMa	S4				X	
PHALACROCORACIDAE								
Microcarbo melanoleucos	Little Pied Cormorant							X
Phalacrocorax sulcirostris	Little Black Cormorant				X			X
PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican				X			
CICONIIDAE								
Ephippiorhynchus asiaticus	Black-necked Stork				X			
ARDEIDAE								
Ardea alba	Great Egret	MiMa					X	
Ardea ibis	Cattle Egret	MiMa					X	

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Ardea modesta	Eastern Great Egret	MiMa			X	X		
Ardea pacifica	White-necked Heron				X			
Nycticorax caledonicus	Rufous Night Heron				X			
THRESKIORNITHIDAE								
Platalea regia	Royal Spoonbill				X			
Threskiornis molucca	Australian White Ibis				X			
Threskiornis spinicollis	Straw-necked Ibis				X			
ACCIPITRIDAE								
Accipiter cirrocephalus	Collared Sparrowhawk				X			
Accipiter fasciatus	Brown Goshawk				X			
Aquila audax	Wedge-tailed Eagle				X			
Circus assimilis	Spotted Harrier				X			
Haliaeetus leucogaster	White-bellied Sea-Eagle	MiMa	S3				X	
Haliastur sphenurus	Whistling Kite				X			X
Milvus migrans	Black Kite				X			X
Pandion cristatus	Eastern Osprey						X	
FALCONIDAE								
Falco berigora	Brown Falcon				X			X
Falco cenchroides	Nankeen Kestrel				X			
Falco hypoleucos	Grey Falcon		S1		X	X		
Falco longipennis	Australian Hobby				X			
Falco peregrinus	Peregrine Falcon		S4			X		
RALLIDAE								
Fulica atra	Eurasian Coot				X			X
OTIDIDAE								
Ardeotis australis	Australian Bustard			P4	X	X		
BURHINIDAE								
Burhinus grallarius	Bush stone curlew			P4	X	X		
RECURVIROSTRIDAE								
Himantopus himantopus	Black-winged Stilt				X			
CHARADRIIDAE								
Charadrius melanops	Black-fronted Dotterel				X			X
Charadrius veredus	Oriental Plover	MiMa					X	
ROSTRATULIDAE								
Rostratula australis	Australian Painted Snipe	En,					X	
SCOLOPACIDAE								
Calidris acuminata	Sharp-tailed Sandpiper	MiMa			X	X		
Tringa glareola	Wood Sandpiper	MiMa			X	X		
TURNICIDAE								
Turnix velox	Little Button-quail				X			
LARIDAE								
Gelochelidon nilotica	Gull-billed Tern							X
CACATUIDAE								
Cacatua roseicapilla	Galah							X
Cacatua sanguinea	Little Corella							X
PSITTACIDAE								

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Cacatua roseicapilla	Galah				X			
Cacatua sanguinea	Little Corella				X			
Melopsittacus undulatus	Budgerigar				X			
Nymphicus hollandicus	Cockatiel				X			
Pezoporus occidentalis	Night Parrot	En					X	
Platycercus zonarius	Australian Ringneck				X			
Polytelis alexandrae	Princess Parrot	Vu		P4			X	
CUCULIDAE								
Centropus phasianinus	Pheasant Coucal				X			
Cuculus pallidus	Pallid Cuckoo				X			
Chrysococcyx basalis	Horsfield's Bronze Cuckoo				X			
STRIGIDAE								
Ninox connivens	Barking Owl			P2		X		
Ninox novaeseelandiae	Boobook Owl				X			
HALCYONIDAE								
Dacelo leachii	Blue-winged Kookaburra				X			
Todiramphus pyrrhopygius	Red-backed Kingfisher				X			
Todiramphus sanctus	Sacred Kingfisher				X			X
MEROPIDAE								
Merops ornatus	Rainbow Bee-eater	Mi	S4		X	X	X	X
PTILONORHYNCHIDAE								
Ptilonorhynchus guttata	Western Bowerbird				X			
ACANTHIZIDAE								
Acanthiza robustirostris	Slaty-backed Thornbill				X			
Gerygone fusca	Western Gerygone				X			
Smicrornis brevirostris	Weebill				X			
PARDALOTIDAE								
Pardalotus rubricatus	Red-browed Pardalote				X			
Pardalotus striatus	Striated Pardalote				X			
MELIPHAGIDAE								
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				X			
Certhionyx variegatus	Pied Honeyeater				X			
Epthianura tricolor	Crimson Chat				X			
Lichmera indistincta	Brown Honeyeater				X			
Manorina flavigula	Yellow-throated Miner				X			
Melithreptus gularis	Black-chinned Honeyeater				X			
Ptilotula keartlandi	Grey-headed Honeyeater)				X			X
Ptilotula penicillatus	White-plumed Honeyeater				X			X
Sugomel niger	Black Honeyeater				X			
POMATOSTOMIDAE								
Pomatostomus superciliosus	White-browed Babbler				X			
Pomatostomus temporalis	Grey-crowned Babbler				X			
PSOPHODIDAE								
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush				X			
CAMPEPHAGIDAE								
Coracina maxima	Ground Cuckoo-shrike				X			

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Coracina novaehollandiae	Black-faced Cuckoo-shrike				X			X
Lalage tricolor	White-winged Triller				X			
PACHYCEPHALIDAE								
Colluricincla harmonica	Grey Shrike-thrush				X			X
Oreoica gutturalis	Crested Bellbird				X			
Pachycephala rufiventris	Rufous Whistler				X			
ARTAMIDAE								
Artamus cinereus	Black-faced Woodswallow				X			
Artamus minor	Little Woodswallow				X			
Artamus personatus	Masked Woodswallow				X			
CRACTICIDAE								
Cracticus nigrogularis	Pied Butcherbird				X			X
Gymnorhina tibicen	Australian Magpie				X			
RHIPIDURIDAE								
Rhipidura leucophrys	Willie Wagtail				X			X
MONARCHIDAE								
Grallina cyanoleuca	Magpie-Lark				X			X
CORVIDAE								
Corvus bennetti	Little Crow				X			
Corvus orru	Torresian Crow				X			X
PETROICIDAE								
Petroica cucullata	Hooded Robin				X			
MALURIDAE								
Amytornis striatus subsp. striatus	Striated Grasswren (inland)		P4		X			
Amytornis striatus subsp. whitei	Striated Grasswren				X			X
Malurus lamberti	Variegated Fairy-wren				X			
Malurus leucopterus	White-winged Fairy-wren				X			
ALAUDIDAE								
Mirafra javanica	Horsfield's Bushlark				X			
ACROCEPHALIDAE								
Acrocephalus australis	Australian Reed Warbler				X			
MEGALURIDAE								
Cincloramphus cruralis	Brown Songlark				X			
Cincloramphus mathewsi	Rufous Songlark				X			
Eremiornis carteri	Spinifexbird				X			
HIRUNDINIDAE								
Hirundo ariel	Fairy Martin				X			
Hirundo neoxena	Welcome Swallow				X			
Hirundo nigricans	Tree Martin				X			
NECTARINIIDAE								
Dicaeum hirundinaceam	Mistletoebird				X			
ESTRILDIDAE								
Emblema pictum	Painted Finch				X			X
Neochmia ruficauda	Star Finch				X			
Taeniopygia guttata	Zebra Finch				X			X
MOTACILLIDAE								

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Anthus australis	Australian Pipit				X			

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Note: For Definitions of Conservation Codes see Appendix A.

MAMMALS			Conservation Codes					
Scientific Name	**Common Name**	**EPBC**	**WC**	**DPaW**	**A**	**B**	**C**	**D**
TACHYGLOSSIDAE								
Tachyglossus aculeatus	Short-beaked Echidna				X			
DASYURIDAE								
Dasycercus blythi	Brush-tailed Mulgara			P4	X	X		
Dasykaluta rosamondae	Little Red Kaluta			P4	X			X
Dasyurus hallucatus	Northern Quoll	En	S1		X	X	X	X
Ningaui timealeyi	Pilbara Ningaui				X			X
Planigale ingrami	Long-tailed Planigale				X			
Planigale maculata	Common Planigale				X			
Pseudantechinus roryi	Rory's Pseudantechinus				X			
Pseudantechinus woolleyae	Woolley's Pseudantechinus				X			
Sminthopsis longicaudata	Long-tailed Dunnart			P4		X		
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart				X			
THYLACOMYIDAE								
Macrotis lagotis	Bilby	Vu	S1		X	X		
PHALANGERIDAE								
Trichosurus vulpecula	Common Brushtail Possum				X			
Trichosurus vulpecula subsp. Arnhemensis	Northern Brushtail Possum				X			
MACROPODIDAE								
Macropus robustus	Common Wallaroo				X			X
Macropus rufus	Red Kangaroo				X			
Petrogale rothschildi	Rothschild's Rock-wallaby				X			
MEGADERMATIDAE								
Macroderma gigas	Ghost bat			P4	X	X		
NOTORYCTIDAE								
Notoryctes caurinus	Northern Marsupial Mole	En	S1				X	
HIPPOSIDERIDAE								
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	Vu	S1		X	X	X	X
EMBALLONURIDAE								
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat				X			X
Taphozous georgianus	Common Sheathtail-bat				X			X
Taphozous hilli	Hill's Sheathtail-bat				X			
MOLOSSIDAE								
Chaerephon jobensis	Northern Freetail Bat				X			X
Mormopterus lumsdenae	Beccari's Free-tailed Bat				X			X
Tadarida australis	White-striped Freetail-bat				X			
VESPERTILIONIDAE								

MAMMALS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DPaW	A	B	C	D
Chalinolobus gouldii	Gould's Wattled Bat				X			X
Nyctophilus geoffroyi	Lesser Long-eared Bat				X			
Scotorepens greyii	Little Broad-nosed Bat				X			X
Vespadelus finlaysoni	Finlayson's Cave Bat				X			X
MURIDAE								
Mus musculus	House Mouse				X		X	
Pseudomys chapmani	Western Pebble Mouse			P4	X	X		X
Pseudomys delicatulus	Delicate Mouse				X			
Pseudomys desertor	Desert Mouse				X			X
Pseudomys hermannsburgensis	Sandy Inland Mouse				X			
Zyzomys argurus	Common Rock-rat				X			
LEPORIDAE								
Oryctolagus cuniculus	European Rabbit						X	
CANIDAE								
Canis lupus familiaris	Domestic Dog				X		X	
Canis lupus subsp. Dingo	Dingo				X			
CARNIVORA								
Vulpes vulpes	Fox						X	
FELIDAE								
Felis catus	Feral Cat				X		X	
EQUIDAE								
Equus asinus	Donkey				X		X	
Equus caballus	Horse						X	
SUIDAE								
Sus scrofa	Pig						X	
CAMELIDAE								
Camelus dromedarius	Dromedary				X		X	
BOVIDAE								
Bos taurus	Cattle				X			

APPENDIX C

Database Searches

NAME	SOURCE_CODE	SOURCE_ID	NAME_ID	FAMILY	GENUS	SPECIES	INFRARANK	INFRANAME	AUTHOR	VERNACULAR	KINGDOM	CONSV_CODE	CLASS	LOCALITY_NAME	SITE_NAME	DAY	MONTH	YEAR
Dasyurus hallucatus	FAUNASURVEY	253971	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	13	08	2011
Dasyurus hallucatus	FAUNASURVEY	424628	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	05	03	2012
Dasyurus hallucatus	TFAUNA	14030	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	NULLAGINE	01	01	1979
Dasyurus hallucatus	FAUNASURVEY	487625	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek	07	08	2012
Dasyurus hallucatus	FAUNASURVEY	424623	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: CAM REC1 D3	05	03	2012
Dasyurus hallucatus	FAUNASURVEY	424625	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: NewGully	06	03	2012
Dasyurus hallucatus	FAUNASURVEY	253966	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	07	08	2011
Dasyurus hallucatus	FAUNASURVEY	487623	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek	07	08	2012
Dasyurus hallucatus	FAUNASURVEY	253970	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	12	08	2011
Dasyurus hallucatus	FAUNASURVEY	424627	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	04	03	2012
Dasyurus hallucatus	FAUNASURVEY	424626	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	03	03	2012
Dasyurus hallucatus	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M24352	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE		09	12	1899
Falco hypoleucos	TFAUNA	3211	24473	Falconidae	Falco	hypoleucos			Gould	Grey Falcon	Animalia	T	BIRD	NULLAGINE	Nullagine	19	05	1994
Falco hypoleucos	TFAUNA	3695	24473	Falconidae	Falco	hypoleucos			Gould	Grey Falcon	Animalia	T	BIRD	NULLAGINE	Nullagine	12	11	1997
Liasis olivaceus subsp. barroni	FAUNASURVEY	256393	25238	Boidae	Liasis	olivaceus	subsp.	barroni	Smith	Pilbara Olive Python	Animalia	T	REPTILE	NULLAGINE	BonnieDowns	03	06	2011
Macrotis lagotis	FAUNASURVEY	668307	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	FAUNASURVEY	668305	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	TFAUNA	21167	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Pilbara	23	08	2012
Macrotis lagotis	FAUNASURVEY	153905	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	MMB1	02	09	2010
Macrotis lagotis	FAUNASURVEY	668306	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	TFAUNA	3749	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Nullagine	14	06	1979
Rhinonicteris aurantia	TFAUNA	12732	43368	Hipposideridae	Rhinonicteris	aurantia			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Nullagine	23	08	2006
Rhinonicteris aurantius	FAUNASURVEY	472434	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	MARBLE BAR	Uncle Toms Mine	08	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472416	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472419	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	425280	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SM2 06 D2	01	03	2012
Rhinonicteris aurantius	FAUNASURVEY	472427	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	06	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472421	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	09	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472423	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472430	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Marble Bar Road	09	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472422	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Rhinonicteris aurantius	FAUNASURVEY	425279	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SM2 01 D2	01	03	2012
Rhinonicteris aurantius	FAUNASURVEY	472428	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	07	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472426	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	07	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472425	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	06	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472417	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472420	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	02	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472424	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Falco peregrinus	FAUNASURVEY	244854	25624	Falconidae	Falco	peregrinus			Tunstall	Peregrine Falcon	Animalia	S	BIRD	NULLAGINE	977-Vert06	16	04	2011
Falco peregrinus	BIRDATLAS2	476246|237	25624	Falconidae	Falco	peregrinus			Tunstall	Peregrine Falcon	Animalia	S	BIRD	NULLAGINE	Noreena-Roy Hill Rd	07	06	2006
Ardea modesta	BIRDATLAS2	5074141|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Nullagine	30	10	2010
Ardea modesta	BIRDATLAS2	449236|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Nullagine	25	06	2004
Ardea modesta	BIRDATLAS2	412391|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Garden Pool	20	07	2003
Ardea modesta	BIRDATLAS2	776174|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Mine Pools	13	08	2007
Ardea modesta	BIRDATLAS2	776173|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Garden Pool	11	08	2007
Calidris acuminata	BIRDATLAS2	5072299|163	24779	Scolopacidae	Calidris	acuminata			(Horsfield)	Sharp-tailed Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullargine Lagoon	30	10	2010
Merops ornatus	BIRDATLAS1	20938|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE		10	06	1977
Merops ornatus	BIRDATLAS2	160979|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool, Nullagine	09	07	2001
Merops ornatus	BIRDATLAS2	460783|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine River	06	09	2005
Merops ornatus	BIRDATLAS2	5031170|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	GardenPool near Nullagine	13	09	2008
Merops ornatus	BIRDATLAS2	460779|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine River, Garden Pool	24	07	2005
Merops ornatus	BIRDATLAS2	412391|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	20	07	2003
Merops ornatus	BIRDATLAS1	82615|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE		25	09	1979
Merops ornatus	BIRDATLAS2	275822|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine Road	27	06	2001
Merops ornatus	BIRDATLAS2	449237|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine R Garden Pool	25	06	2004
Merops ornatus	BIRDATLAS2	776119|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	09	08	2006
Merops ornatus	BIRDATLAS2	286770|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	24	07	2002
Merops ornatus	FAUNASURVEY	425137	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	04	03	2012
Merops ornatus	FAUNASURVEY	425144	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	03	03	2012
Merops ornatus	FAUNASURVEY	425150	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	04	03	2012
Merops ornatus	FAUNASURVEY	153965	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	01	09	2010
Merops ornatus	FAUNASURVEY	153951	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	20	05	2010
Merops ornatus	FAUNASURVEY	668436	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	07	07	2013
Merops ornatus	FAUNASURVEY	425135	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	01	03	2012
Merops ornatus	FAUNASURVEY	425136	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	02	03	2012
Merops ornatus	FAUNASURVEY	153963	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB3	30	08	2010
Merops ornatus	FAUNASURVEY	425146	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	05	03	2012
Merops ornatus	FAUNASURVEY	668434	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	07	07	2013
Merops ornatus	FAUNASURVEY	153955	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS2	21	05	2010
Merops ornatus	FAUNASURVEY	425134	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 1	02	03	2012
Merops ornatus	FAUNASURVEY	153959	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	24	05	2010
Merops ornatus	FAUNASURVEY	153952	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	20	05	2010
Merops ornatus	FAUNASURVEY	153960	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF4	24	05	2010
Merops ornatus	FAUNASURVEY	425151	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	05	03	2012
Merops ornatus	FAUNASURVEY	425153	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	02	03	2012
Merops ornatus	BIRDATLAS2	776173|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	11	08	2007
Merops ornatus	FAUNASURVEY	425143	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	03	03	2012
Merops ornatus	FAUNASURVEY	425141	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	07	03	2012
Merops ornatus	FAUNASURVEY	425138	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	05	03	2012
Merops ornatus	FAUNASURVEY	425130	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: Calcrete	07	03	2012
Merops ornatus	FAUNASURVEY	153961	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	24	05	2010
Merops ornatus	FAUNASURVEY	153966	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	01	09	2010
Merops ornatus	FAUNASURVEY	153950	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB1	20	05	2010
Merops ornatus	FAUNASURVEY	425132	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: CID	05	03	2012
Merops ornatus	FAUNASURVEY	153967	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	02	09	2010
Merops ornatus	BIRDATLAS2	281283|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	146 Bonney downs	02	09	2002
Merops ornatus	FAUNASURVEY	153958	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	23	05	2010
Merops ornatus	FAUNASURVEY	153962	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	25	05	2010
Merops ornatus	FAUNASURVEY	153954	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	21	05	2010
Merops ornatus	FAUNASURVEY	153968	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	02	09	2010
Merops ornatus	FAUNASURVEY	425147	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	07	03	2012
Merops ornatus	FAUNASURVEY	425148	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	01	03	2012
Merops ornatus	BIRDATLAS2	476246|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Noreena-Roy Hill Rd	07	06	2006
Merops ornatus	FAUNASURVEY	668435	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	04	07	2013
Merops ornatus	BIRDATLAS2	476295|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Cajaput Creek	17	06	2006
Merops ornatus	FAUNASURVEY	153956	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	22	05	2010
Merops ornatus	FAUNASURVEY	425142	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	08	03	2012
Merops ornatus	FAUNASURVEY	425129	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: Calcrete	04	03	2012
Merops ornatus	FAUNASURVEY	153953	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	20	05	2010
Tringa glareola	BIRDATLAS2	5074141|154	24806	Scolopacidae	Tringa	glareola			Linnaeus	Wood Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullagine	30	10	2010
Tringa glareola	BIRDATLAS2	5072299|154	24806	Scolopacidae	Tringa	glareola			Linnaeus	Wood Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullargine Lagoon	30	10	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166162	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	07	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153600	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	21	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166159	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	03	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153599	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB4	20	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166167	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	11	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166165	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	07	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166166	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	16	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166161	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	09	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153604	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	23	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166163	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	12	09	2006

Ctenotus nigrilineatus	FAUNASURVEY	153605	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB4	25	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153601	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB2	22	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153610	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	02	09	2010
Ctenotus nigrilineatus	FAUNASURVEY	153602	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	23	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153607	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	31	08	2010
Ctenotus nigrilineatus	FAUNASURVEY	153597	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF1	03	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153606	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	30	08	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166164	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	31	08	2006
Ctenotus nigrilineatus	FAUNASURVEY	153608	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	01	09	2010
Ninox connivens subsp. connivens	TFAUNA	11933	24819	Strigidae	Ninox	connivens	subsp.	connivens	(Latham)	Barking Owl (southwest pop P2), Barking Owl	Animalia	2	BIRD	NULLAGINE	Nullagine	28	12	2005
Ardeotis australis	BIRDATLAS1	82618|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE		13	08	1979
Ardeotis australis	BIRDATLAS2	113455|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Marble Bar Road	21	08	2000
Ardeotis australis	BIRDATLAS1	20938|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE		10	06	1977
Ardeotis australis	FAUNASURVEY	667656	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	04	07	2013
Ardeotis australis	FAUNASURVEY	244307	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert06	18	04	2011
Ardeotis australis	FAUNASURVEY	667658	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	03	07	2013
Ardeotis australis	BIRDATLAS2	776172|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Cajaput Creek	11	08	2007
Ardeotis australis	FAUNASURVEY	244308	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert06	01	04	2011
Ardeotis australis	FAUNASURVEY	244305	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Opportunistic Site 02	17	04	2011
Ardeotis australis	FAUNASURVEY	153447	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	MMS2	01	09	2010
Ardeotis australis	FAUNASURVEY	244309	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert07	16	04	2011
Ardeotis australis	FAUNASURVEY	667657	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	07	07	2013
Burhinus grallarius	BIRDATLAS2	776119|174	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Garden Pool	09	08	2006
Burhinus grallarius	FAUNASURVEY	424328	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	McPhee Creek: MC TARG1 0305	05	03	2012
Burhinus grallarius	FAUNASURVEY	667691	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Mt Webber	04	07	2013
Burhinus grallarius	FAUNASURVEY	667692	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Mt Webber	05	07	2013
Burhinus grallarius	FAUNASURVEY	424329	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	29	02	2012
Dasycercus blythi	FAUNASURVEY	153665	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	MMB1	02	09	2010
Dasycercus blythi	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M2745	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	BLUE SPEC MINING CENTRE			
Dasycercus blythi	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3456	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE		26	05	1959
Dasycercus blythi	TFAUNA	16374	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	Nullagine	26	05	1959
Dasycercus blythi	FAUNASURVEY	153666	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	MMB1	05	09	2010
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M15233	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	CAVE	26	08	1976
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3161	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3155	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3150	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	TFAUNA	12725	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Nullagine	08	09	2006
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M2553	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	ALL NATIONS MINE			
Macroderma gigas	FAUNASURVEY	424991	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: CID	04	03	2012
Macroderma gigas	FAUNASURVEY	472439	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	09	05	2012
Macroderma gigas	FAUNASURVEY	472440	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	10	09	2012
Macroderma gigas	TFAUNA	12723	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Nullagine	07	09	2006
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3163	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4802	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	ALL NATIONS MINE	09	12	1899
Macroderma gigas	FAUNASURVEY	472437	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3152	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3159	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3284	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE		09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4681	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,OLD	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3158	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	FAUNASURVEY	472438	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3162	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3151	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	FAUNASURVEY	472435	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Lionel Mine	07	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4683	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE		09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3156	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3160	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3153	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	FAUNASURVEY	472436	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3149	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Pseudomys chapmani	FAUNASURVEY	244113	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	FAUNASURVEY	244112	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	FAUNASURVEY	425256	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: MY TARG1 0308	08	03	2012
Pseudomys chapmani	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M57928	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	21KM WNW BONNEY DOWNS HOMESTEAD	07	05	2005
Pseudomys chapmani	FAUNASURVEY	425255	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: MY TARG1 0308	08	03	2012
Pseudomys chapmani	TFAUNA	5333	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	Galteemore	01	01	1994
Pseudomys chapmani	FAUNASURVEY	244095	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	TFAUNA	20674	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	Pilbara	18	03	1993
Sminthopsis longicaudata	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M57925	24115	Dasyuridae	Sminthopsis	longicaudata			Spencer	Long-tailed Dunnart	Animalia	4	MAMMAL	NULLAGINE	21KM WNW BONNEY DOWNS HOMESTEAD	05	05	2005

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

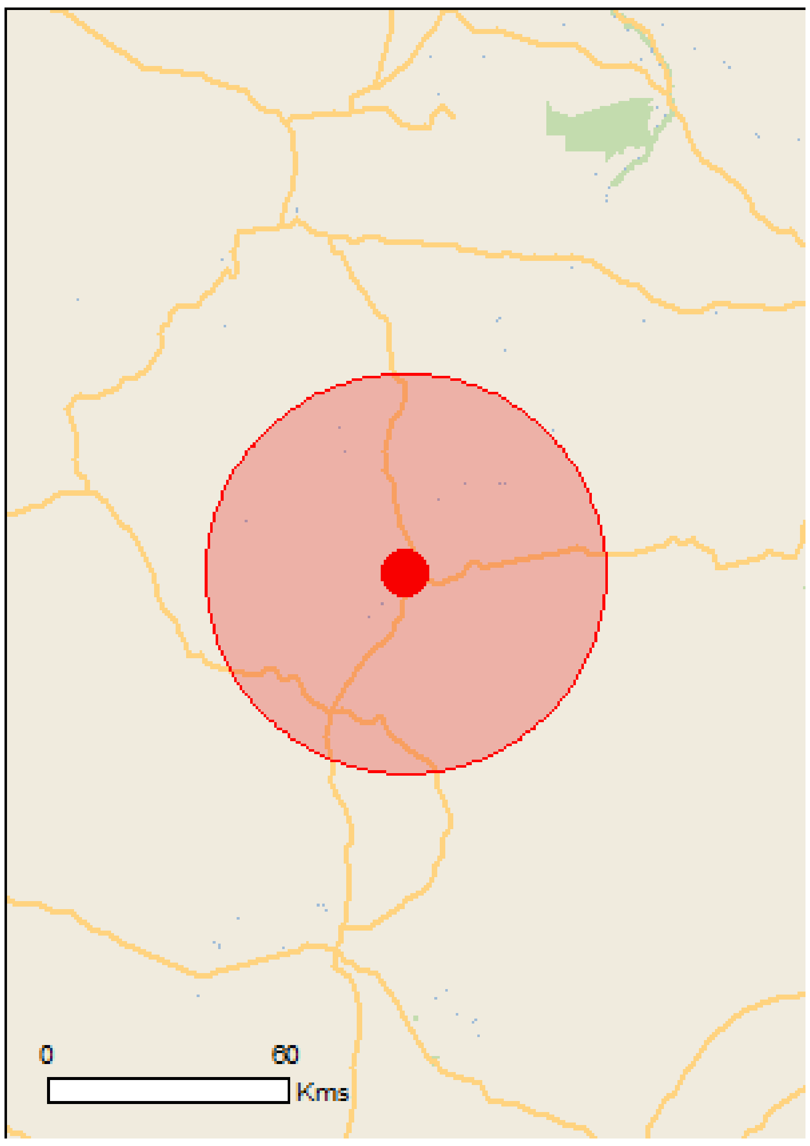
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

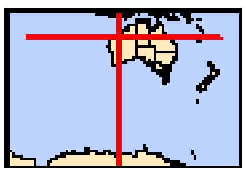
Report created: 18/11/14 19:58:52

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates

Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	9
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	8
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

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

Place on the RNE:	3
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	13
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae		
Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus		
Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus		
Kakarratul, Northern Marsupial Mole [295]	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Lepidium catapycnon		
Hamersley Lepidium, Hamersley Catapycnon [9397]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Garden Pool Geological Site	WA	Indicative Place
Historic		
Bonney Downs Homestead	WA	Indicative Place
Conglomerate Hotel	WA	Indicative Place

State and Territory Reserves [Resource Information]

Name	State
Meenthena Station	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Coordinates

-21.88641 120.10808

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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NatureMap Species Report

Created By Guest user on 17/11/2014

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Reptiles
Method	'By Circle'
Centre	120°06' 30" E,21°53' 08" S
Buffer	39km
Group By	Family

Family	Species	Records
Agamidae	7	131
Boidae	6	11
Diplodactylidae	9	128
Elapidae	11	40
Gekkonidae	6	131
Pygopodidae	5	41
Scincidae	38	484
Typhlopidae	4	40
Varanidae	9	62
TOTAL	**95**	**1068**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Agamidae					
1.	30831	*Amphibolurus gilberti (Ta-ta, Gilbert's Dragon)*			
2.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
3.	25458	*Ctenophorus caudicinctus (Ring-tailed Dragon)*			
4.	24865	*Ctenophorus caudicinctus subsp. caudicinctus (Ring-tailed Dragon)*			
5.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
6.	24882	*Ctenophorus nuchalis (Central Netted Dragon)*			
7.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
Boidae					
8.	25318	*Antaresia perthensis (Pygmy Python)*			
9.	25448	*Antaresia stimsoni (Stimson's Python)*			
10.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
11.	25320	*Aspidites melanocephalus (Black-headed Python)*			
12.	25486	*Liasis olivaceus (Olive Python)*			
13.	25238	*Liasis olivaceus subsp. barroni (Pilbara Olive Python)*		T	
Diplodactylidae					
14.	25456	*Crenadactylus ocellatus (Clawless Gecko)*			
15.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
16.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
17.	24944	*Diplodactylus savagei (Southern Pilbara Beak-faced Gecko)*			
18.	30933	*Lucasium stenodactylum*			
19.	30934	*Lucasium wombeyi*			
20.	24976	*Oedura marmorata (Marbled Velvet Gecko)*			
21.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
22.	24927	*Strophurus elderi*			
Elapidae					
23.	25332	*Acanthophis wellsi (Pilbara Death Adder)*			
24.	25331	*Brachyurophis approximans (North-western Shovel-nosed Snake)*			
25.	25468	*Demansia psammophis (Yellow-faced Whipsnake)*			
26.	25297	*Demansia rufescens (Rufous Whipsnake)*			
27.	25301	*Furina ornata (Moon Snake)*			
28.	25261	*Pseudechis australis (Mulga Snake)*			
29.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
30.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
31.	25264	*Pseudonaja nuchalis (Gwardar, Northern Brown Snake)*			
32.	25269	*Suta fasciata (Rosen's Snake)*			

NatureMap
Mapping Western Australia's biodiversity

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
33.	25307	*Suta punctata (Spotted Snake)*			
Gekkonidae					
34.	24956	*Gehyra pilbara*			
35.	24958	*Gehyra punctata*			
36.	24957	*Gehyra purpurascens*			
37.	24959	*Gehyra variegata*			
38.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
39.	24962	*Heteronotia spelea (Desert Cave Gecko)*			
Pygopodidae					
40.	24998	*Delma elegans*			
41.	25001	*Delma nasuta*			
42.	25002	*Delma pax*			
43.	25004	*Delma tincta*			
44.	25005	*Lialis burtonis*			
Scincidae					
45.	25015	*Carlia munda (Shaded-litter Rainbow Skink)*			
46.	30892	*Cryptoblepharus ustulatus*			
47.	25036	*Ctenotus duricola*			
48.	25462	*Ctenotus grandis*			
49.	25041	*Ctenotus grandis subsp. grandis*			
50.	25043	*Ctenotus grandis subsp. titan*			
51.	25044	*Ctenotus hanloni*			
52.	25045	*Ctenotus helenae*			
53.	25052	*Ctenotus leonhardii*			
54.	25058	*Ctenotus nigrilineatus (Black-lined Ctenotus, Pin-striped Fine-snout Skink)*		P1	
55.	25463	*Ctenotus pantherinus (Leopard Ctenotus)*			
56.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
57.	25065	*Ctenotus pantherinus subsp. pantherinus (Leopard Ctenotus)*			
58.	25062	*Ctenotus piankai*			
59.	25072	*Ctenotus rubicundus*			
60.	25071	*Ctenotus rutilans*			
61.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
62.	25074	*Ctenotus schomburgkii*			
63.	25466	*Cyclodomorphus melanops (Slender Blue-tongue)*			
64.	25090	*Cyclodomorphus melanops subsp. melanops (Slender Blue-tongue)*			
65.	41406	*Egernia cygnitos (Western Pilbara Spiny-tailed Skink)*			
66.	25094	*Egernia formosa*			
67.	25101	*Egernia pilbarensis (Pilbara Skink)*			
68.	-18426	*Glaphyromorphus sp.*			Y
69.	25125	*Lerista bipes*			
70.	25135	*Lerista flammicauda*			
71.	30929	*Lerista jacksoni*			
72.	25155	*Lerista muelleri*			
73.	30925	*Lerista verhmens*			
74.	25184	*Menetia greyii*			
75.	25187	*Menetia surda subsp. surda*			
76.	25495	*Morethia ruficauda*			
77.	25193	*Morethia ruficauda subsp. exquisita*			
78.	25499	*Notoscincus ornatus*			
79.	25197	*Notoscincus ornatus subsp. ornatus*			
80.	25199	*Proablepharus reginae*			
81.	25202	*Tiliqua multifasciata (Central Blue-tongue)*			
82.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
Typhlopidae					
83.	25270	*Ramphotyphlops ammodytes*			
84.	25277	*Ramphotyphlops grypus*			
85.	25279	*Ramphotyphlops hamatus*			
86.	25315	*Ramphotyphlops pilbarensis*			
Varanidae					
87.	25209	*Varanus acanthurus (Spiny-tailed Monitor)*			
88.	25210	*Varanus brevicauda (Short-tailed Pygmy Monitor)*			
89.	25211	*Varanus caudolineatus*			
90.	25212	*Varanus eremius (Pygmy Desert Monitor)*			
91.	25216	*Varanus giganteus (Perentie)*			
92.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
93.	25524	*Varanus panoptes (Yellow-spotted Monitor)*			
94.	25224	*Varanus pilbarensis (Pilbara Rock Monitor)*			
95.	25526	*Varanus tristis (Racehorse Monitor)*			

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap Species Report

Created By Guest user on 18/11/2014

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Birds
Method	'By Circle'
Centre	120°06' 29'' E,21°53' 08'' S
Buffer	39km
Group By	Family

Family	Species	Records
Acanthizidae	3	49
Accipitridae	6	54
Aegothelidae	1	5
Alaudidae	1	19
Anatidae	6	25
Ardeidae	3	17
Artamidae	3	101
Burhinidae	1	9
Campephagidae	4	81
Caprimulgidae	1	2
Casuariidae	1	3
Centropodidae	1	4
Charadriidae	1	11
Ciconiidae	1	6
Cinclosomatidae	1	1
Columbidae	5	149
Corvidae	2	63
Cracticidae	2	107
Cuculidae	2	43
Dicaeidae	1	5
Dicruridae	2	129
Estrildidae	3	160
Falconidae	4	76
Halcyonidae	3	38
Hirundinidae	3	21
Maluridae	6	49
Meliphagidae	11	251
Meropidae	1	68
Motacillidae	1	6
Otididae	1	18
Pachycephalidae	3	109
Pardalotidae	2	59
Pelecanidae	1	4
Petroicidae	1	7
Phalacrocoracidae	1	8
Phasianidae	1	3
Podicipedidae	2	6
Pomatostomidae	3	17
Psittacidae	5	158
Ptilonorhynchidae	1	1
Rallidae	1	1
Recurvirostridae	1	1
Scolopacidae	2	3
Strigidae	1	5
Sylviidae	4	113
Threskiornithidae	3	7
Turnicidae	1	56
TOTAL	**114**	**2128**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Acanthizidae					
1.	24264	*Acanthiza robustirostris (Slaty-backed Thornbill)*			
2.	25530	*Gerygone fusca (Western Gerygone)*			
3.	30948	*Smicrornis brevirostris (Weebill)*			
Accipitridae					
4.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
5.	25536	*Accipiter fasciatus (Brown Goshawk)*			
6.	24285	*Aquila audax (Wedge-tailed Eagle)*			
7.	24289	*Circus assimilis (Spotted Harrier)*			
8.	24295	*Haliastur sphenurus (Whistling Kite)*			
9.	25542	*Milvus migrans (Black Kite)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Aegothelidae					
10.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
Alaudidae					
11.	25545	*Mirafra javanica (Horsfield's Bushlark, Singing Bushlark)*			
Anatidae					
12.	24312	*Anas gracilis (Grey Teal)*			
13.	24316	*Anas superciliosa (Pacific Black Duck)*			
14.	24318	*Aythya australis (Hardhead)*			
15.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
16.	24322	*Cygnus atratus (Black Swan)*			
17.	24325	*Dendrocygna eytoni (Plumed Whistling Duck)*			
Ardeidae					
18.	41324	*Ardea modesta (Eastern Great Egret)*		IA	
19.	24341	*Ardea pacifica (White-necked Heron)*			
20.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
Artamidae					
21.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
22.	24355	*Artamus minor (Little Woodswallow)*			
23.	24356	*Artamus personatus (Masked Woodswallow)*			
Burhinidae					
24.	24359	*Burhinus grallarius (Bush Stone-curlew)*		P4	
Campephagidae					
25.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
26.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
27.	24363	*Coracina novaehollandiae subsp. subpallida (Black-faced Cuckoo-shrike)*			
28.	24367	*Lalage tricolor (White-winged Triller)*			
Caprimulgidae					
29.	24368	*Eurostopodus argus (Spotted Nightjar)*			
Casuariidae					
30.	24470	*Dromaius novaehollandiae (Emu)*			
Centropodidae					
31.	25600	*Centropus phasianinus (Pheasant Coucal)*			
Charadriidae					
32.	24373	*Charadrius melanops (Black-fronted Dotterel)*			
Ciconiidae					
33.	25578	*Ephippiorhynchus asiaticus (Black-necked Stork)*			
Cinclosomatidae					
34.	42311	*Cinclosoma marginatum (Western Quail-thrush)*			
Columbidae					
35.	24401	*Geopelia cuneata (Diamond Dove)*			
36.	25585	*Geopelia striata (Zebra Dove)*			
37.	24404	*Geophaps plumifera (Spinifex Pigeon)*			
38.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
39.	24409	*Phaps chalcoptera (Common Bronzewing)*			
Corvidae					
40.	24416	*Corvus bennetti (Little Crow)*			
41.	25593	*Corvus orru (Torresian Crow)*			
Cracticidae					
42.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
43.	25595	*Cracticus tibicen (Australian Magpie)*			
Cuculidae					
44.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
45.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
Dicaeidae					
46.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
Dicruridae					
47.	24443	*Grallina cyanoleuca (Magpie-lark)*			
48.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
Estrilidae					
49.	24631	*Emblema pictum (Painted Finch)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
50.	25685	*Neochmia ruficauda (Star Finch)*			
51.	30870	*Taeniopygia guttata (Zebra Finch)*			

Falconidae

52.	25621	*Falco berigora (Brown Falcon)*			
53.	25622	*Falco cenchroides (Australian Kestrel)*			
54.	24473	*Falco hypoleucos (Grey Falcon)*		T	
55.	25623	*Falco longipennis (Australian Hobby)*			

Halcyonidae

56.	25547	*Dacelo leachii (Blue-winged Kookaburra)*			
57.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
58.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			

Hirundinidae

59.	24489	*Hirundo ariel (Fairy Martin)*			
60.	24491	*Hirundo neoxena (Welcome Swallow)*			
61.	25629	*Hirundo nigricans (Tree Martin)*			

Maluridae

62.	25647	*Amytornis striatus (Striated Grasswren)*			
63.	24539	*Amytornis striatus subsp. striatus (Striated Grasswren (inland))*		P4	
64.	24540	*Amytornis striatus subsp. whitei (Striated Grasswren)*			
65.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
66.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
67.	24549	*Malurus leucopterus subsp. leuconotus (White-winged Fairy-wren)*			

Meliphagidae

68.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
69.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
70.	24570	*Epthianura tricolor (Crimson Chat)*			
71.	25661	*Lichmera indistincta (Brown Honeyeater)*			
72.	24582	*Lichmera indistincta subsp. indistincta (Brown Honeyeater)*			
73.	24583	*Manorina flavigula (Yellow-throated Miner)*			
74.	25665	*Melithreptus gularis (Black-chinned Honeyeater)*			
75.	24589	*Melithreptus gularis subsp. laetior (Black-chinned Honeyeater)*			
76.	42323	*Ptilotula keartlandi (Grey-headed Honeyeater)*			
77.	42341	*Ptilotula penicillatus (White-plumed Honeyeater)*			
78.	42310	*Sugomel niger (Black Honeyeater)*			

Meropidae

79.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	

Motacillidae

80.	25670	*Anthus australis (Australian Pipit)*			

Otididae

81.	24610	*Ardeotis australis (Australian Bustard)*		P4	

Pachycephalidae

82.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
83.	24618	*Oreoica gutturalis (Crested Bellbird)*			
84.	25680	*Pachycephala rufiventris (Rufous Whistler)*			

Pardalotidae

85.	24627	*Pardalotus rubricatus (Red-browed Pardalote)*			
86.	25682	*Pardalotus striatus (Striated Pardalote)*			

Pelecanidae

87.	24648	*Pelecanus conspicillatus (Australian Pelican)*			

Petroicidae

88.	24658	*Petroica cucullata (Hooded Robin)*			

Phalacrocoracidae

89.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			

Phasianidae

90.	25701	*Coturnix ypsilophora (Brown Quail)*			

Podicipedidae

91.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
92.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			

Pomatostomidae

93.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
94.	25706	*Pomatostomus temporalis (Grey-crowned Babbler)*			
95.	24684	*Pomatostomus temporalis subsp. rubeculus (Grey-crowned Babbler)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Psittacidae					
96.	25715	*Cacatua roseicapilla (Galah)*			
97.	25716	*Cacatua sanguinea (Little Corella)*			
98.	24736	*Melopsittacus undulatus (Budgerigar)*			
99.	24742	*Nymphicus hollandicus (Cockatiel)*			
100.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
Ptilonorhynchidae					
101.	24757	*Ptilonorhynchus maculatus subsp. guttatus (Western Bowerbird)*			
Rallidae					
102.	25727	*Fulica atra (Eurasian Coot)*			
Recurvirostridae					
103.	25734	*Himantopus himantopus (Black-winged Stilt)*			
Scolopacidae					
104.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
105.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
Strigidae					
106.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
Sylviidae					
107.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
108.	24833	*Cincloramphus cruralis (Brown Songlark)*			
109.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			
110.	24837	*Eremiornis carteri (Spinifex-bird)*			
Threskiornithidae					
111.	24842	*Platalea regia (Royal Spoonbill)*			
112.	24844	*Threskiornis molucca (Australian White Ibis)*			
113.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
Turnicidae					
114.	24851	*Turnix velox (Little Button-quail)*			

Conservation Codes
T - Rare or likely to become extinct
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[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap Species Report

Created By Guest user on 17/11/2014

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Mammals
Method	'By Circle'
Centre	120°06' 30" E,21°53' 08" S
Buffer	39km
Group By	Family

Family	Species	Records
Bovidae	1	13
Camelidae	1	3
Canidae	3	15
Dasyuridae	9	104
Emballonuridae	3	59
Equidae	1	5
Felidae	1	13
Hipposideridae	1	2
Macropodidae	4	71
Megadermatidae	1	30
Molossidae	3	19
Muridae	6	67
Phalangeridae	2	2
Tachyglossidae	1	5
Thylacomyidae	1	9
Vespertilionidae	4	227
TOTAL	**42**	**644**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Bovidae					
1.	24251	*Bos taurus (European Cattle)*	Y		
Camelidae					
2.	24254	*Camelus dromedarius (Dromedary, Camel)*	Y		
Canidae					
3.	25454	*Canis lupus (Dog, Dingo)*	Y		
4.	24039	*Canis lupus subsp. dingo (Dingo)*	Y		
5.	30883	*Canis lupus subsp. familiaris (Dog)*	Y		
Dasyuridae					
6.	30903	*Dasycercus blythi (Brush-tailed Mulgara, Ampurta)*		P4	
7.	24091	*Dasykaluta rosamondae (Little Red Kaluta)*			
8.	24093	*Dasyurus hallucatus (Northern Quoll)*		T	
9.	24095	*Ningaui timealeyi (Pilbara Ningaui)*			
10.	24101	*Planigale ingrami (Long-tailed Planigale)*			
11.	24102	*Planigale maculata (Common Planigale)*			
12.	24105	*Pseudantechinus roryi (Rory's Pseudantechinus)*			
13.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
14.	24120	*Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)*			
Emballonuridae					
15.	24174	*Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)*			
16.	24175	*Taphozous georgianus (Common Sheathtail-bat)*			
17.	24176	*Taphozous hilli (Hill's Sheathtail-bat)*			
Equidae					
18.	24257	*Equus asinus (Donkey)*	Y		
Felidae					
19.	24041	*Felis catus (Cat)*	Y		
Hipposideridae					
20.	43368	*Rhinonicteris aurantia (Orange Leafnosed-bat)*		T	
Macropodidae					

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
21.	25489	*Macropus robustus (Euro)*			
22.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
23.	24136	*Macropus rufus (Red Kangaroo, Marlu)*			
24.	24144	*Petrogale rothschildi (Rothschild's Rock-wallaby)*			
Megadermatidae					
25.	24180	*Macroderma gigas (Ghost Bat)*		P4	
Molossidae					
26.	24181	*Chaerephon jobensis (Northern Freetail-bat)*			
27.	24182	*Mormopterus beccarii (Beccari's Freetail-bat)*			
28.	24185	*Tadarida australis (White-striped Freetail-bat)*			
Muridae					
29.	24223	*Mus musculus (House Mouse)*	Y		
30.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
31.	24234	*Pseudomys delicatulus (Delicate Mouse)*			
32.	24235	*Pseudomys desertor (Desert Mouse)*			
33.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
34.	24248	*Zyzomys argurus (Common Rock-rat)*			
Phalangeridae					
35.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
36.	24157	*Trichosurus vulpecula subsp. arnhemensis (Northern Brushtail Possum)*			
Tachyglossidae					
37.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
Thylacomyidae					
38.	24168	*Macrotis lagotis (Bilby, Dalgyte)*		T	
Vespertilionidae					
39.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
40.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
41.	24200	*Scotorepens greyii (Little Broad-nosed Bat)*			
42.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			

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APPENDIX D

Fauna Habitat Assessment Sheets

Habitat Assessment – Site 1

Date: 02/10/2014
Broad Fauna Habitat:
UTM Co-ordinates 51 Easting: 0200837 Northing: 7579938

Condition Scale: Excellent

Last Fire: long unburnt

Disturbance: no cattle disturbance, some weeds

Aspect: n/a

Soils: light brown sand

Landform: drainage line/stream, sandy

Stratum	Vegetation Species	Average Height	Cover			
			Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus spp.*	4m	<5%	-	-	-
Midstorey	*Acacia* sp,, *Melaleuca* sp., *Hakea* sp.	3-4m	-	-	20-60%	-
Understorey	*Triodia* sp., Sedge	<0.5m	-	<20%	-	-

Ground Cover

Bare Ground:	0%	Grasses:	<20%
Rock:	20-60%	Herbs:	<5%
Leaf Litter:	<20%	Other:	-
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Sand	Peeling Bark:	Moderate
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	Moderate
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	30-70%	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	rare

Bird Species

Crow

Habitat Assessment – Site 2

Date: 08/10/2014

Broad Fauna Habitat:

UTM Co-ordinates 51 Easting: 0201080 Northing: 7579563

Condition Scale: excellent

Last Fire: 4-5 years

Disturbance: no cattle disturbance, some tracks & fire

Aspect: n/a

Soils: red sandy-loam

Landform: Drainage line/stream, stony

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus spp.*	4m	<5%	-	-	-
Midstorey	*Acacia* sp., *Hakea* sp., *Grevillea* sp.	2m	-	-	20-60%	-
Understorey	*Triodia* sp.,	<0.5m	-	-	-	60-100%

Ground Cover

Bare Ground:	20-60%	Grasses:	60-100%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<20%	Other:	-
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	0
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	Moderate
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0-30%	Water Presence:	0
Boulders:	0	Distance to Water:	<0.5km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	rare

Bird Species

Crow

Spinifex pigeon

Habitat Assessment – Site 3

Date:09/10/2014
Broad Fauna Habitat:
UTM Co-ordinates 51 Easting: 0200456 Northing: 7579793

Condition Scale: excellent

Last Fire: long unburnt

Disturbance: no cattle, some tracks

Aspect: SW

Soils: red sandy-loam

Landform: hill, stony

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus spp.*	4m	<5%	-	-	-
Midstorey	Mixed spp. (*Acacia Eremophila*)	1m	-	<20%	-	-
Understorey	*Triodia* sp.	<0.5m	-	-	-	60-100%

Ground Cover

Bare Ground:	20-60%	Grasses:	60-100%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	0
Pebbles/Stones (0-200mm):	70-100%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	-	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	-	Water Presence:	0
Boulders:	-	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	rare

Bird Species

Spinifex pigeon

Crows

White Kite

Black Swan

Coot

Gull-billed tern

Cormorant

Rainbow Bee-eter

Black-fronted dotterel

Painted Finch

Sacred Kingfisher

Habitat Assessment – Q4

Date: 09/10/2014

Broad Fauna Habitat:

UTM Co-ordinates 51 Easting:0199348 Northing: 7577650

Condition Scale: excellent

Last Fire: long unburnt

Disturbance: tracks, drill pads

Aspect: N

Soils: Red-brown sandy-loam

Landform: Hill, stony

Stratum	Vegetation Species	Average Height	Cover			
			Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus* spp.	5m	<5%	-	-	-
Midstorey	*Acacia* sp., mixed unknown sp.	1.5m	-	<20%	-	-
Understorey	*Triodia* sp.	<0.5m	-	-	20-60%	-

Ground Cover

Bare Ground:	60-100%	Grasses:	20-60%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	0
Pebbles/Stones (0-200mm):	70-100%	Small Tree Hollows (<10mm diameter)	rare
Exfoliating Slabs:	0-30%	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0-30%	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	rare

Bird Species

Weebill

Black Faced Cuckoo shrike

Crow

Habitat Assessment – Q5

Date: 09/10/2014

Broad Fauna Habitat: Riverine Woodland

UTM Co-ordinates 51 Easting: 0199816 Northing: 7578006

Condition Scale: very good

Last Fire: 1-3 years

Disturbance: tracks, drill pads

Aspect: n/a

Soils: red/brown sand

Landform: drainage line/stream, sandy

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Cover: Sparse	Cover: Moderate	Cover: Thick
Overstorey	*Eucalyptus spp.*, *Melaleuca* sp.	6m	-	-	20-60%	-
Midstorey	*Acacia* sp.	1.5m	-	-	20-60%	-
Understorey	*Triodia* sp.	<0.5m	-	<20%	-	-

Ground Cover

Bare Ground:	20-60%	Grasses:	<20%
Rock:	20-60%	Herbs:	<5%
Leaf Litter:	<20%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Sand	Peeling Bark:	Moderate
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	Moderate
Exfoliating Slabs:	0-30%	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	30-70%	Water Presence:	0
Boulders:	0-30%	Distance to Water:	0.5-2km
Caves:	present	Termite Mounds:	0
Suitability for Bats:	no	Woody Debris:	rare

Bird Species

Willie Wagtail

Crow

Habitat Assessment – Q6

Date:10/10 /2014

Broad Fauna Habitat:

UTM Co-ordinates 51 Easting: 0199269 Northing: 7577262

Condition Scale: excellent

Last Fire: 1-3 years

Disturbance: tracks and drill pads

Aspect: NE

Soils: red/brown sandy-loam

Landform: hill

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus spp.*	4m	<5%	-	-	-
Midstorey	*Acacia* sp.,	1m	-	-	20-60%	-
Understorey	*Triodia* sp.	<0.5m	-	-	20-60%	-

Ground Cover

Bare Ground:	20-60%	Grasses:	<20-60%
Rock:	20-60%	Herbs:	<5%
Leaf Litter:	20-60%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	Rare
Pebbles/Stones (0-200mm):	70-100%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0-30%	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0-30%	Water Presence:	0
Boulders:	0	Distance to Water:	<0.5km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	rare

Bird Species

Black Faced Cuckoo Shrike

Spinifex pigeon

Crow

Habitat Assessment – HA7

Date: 09/10/2014
Broad Fauna Habitat:
UTM Co-ordinates 51 Easting: 0200677 Northing: 7577621
Condition Scale: completely degraded
Last Fire: n/a
Disturbance: heavy; mining
Aspect: E
Soils: light grey sandy-loam
Landform: sandy plain

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*n/a*	-m	-	-	-	-
Midstorey	*Acacia* sp., some other spp.	-m	<5%	-	-	-
Understorey	*Triodia* sp.	-m	<5%	-	-	-

Ground Cover

Bare Ground:	60-100%	Grasses:	<20%
Rock:	<20%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Sandy loam	Peeling Bark:	0
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	0

Bird Species

Habitat Assessment – HA8

Date: 09/10/2014

Broad Fauna Habitat:

UTM Co-ordinates 51 Easting: 0200005 Northing: 7577497

Condition Scale: degraded

Last Fire: long unburnt

Disturbance: heavy; mining

Aspect: -

Soils: grey sand

Landform: sandy plain

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	n/a	-m	-	-	-	-
Midstorey	*Acacia* sp.(cool bark), mixed shrubs	-m	<5%	-	-	-
Understorey	*Triodia* sp.	-m	-	<20%	-	-

Ground Cover

Bare Ground:	60-100%	Grasses:	<20%
Rock:	<20%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Sand	Peeling Bark:	0
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2%
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	0

Bird Species

Whistling Kite

Habitat Assessment – HA9

Date: /2014

Broad Fauna Habitat:

UTM Co-ordinates 51 Easting: 0199632 Northing: 7579099

Condition Scale: excellent

Last Fire: long unburnt

Disturbance: mild – tracks, drill pads, bags

Aspect: -

Soils: sandy-loam

Landform: hill

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Eucalyptus spp.*	2.5m	<5%	-	-	-
Midstorey	*Acacia* sp.,	1m	<5%	-	-	-
Understorey	*Triodia* sp.	<0.2m	-	-	20-60%	-

Ground Cover

Bare Ground:	20-60%	Grasses:	20-60%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	0
Pebbles/Stones (0-200mm):	70-100%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0-30%	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	0

Bird Species

Habitat Assessment – HA10

Date:09/10 /2014

Broad Fauna Habitat: Low Woodland

UTM Co-ordinates 51 Easting: 0198943 Northing: 7578679

Condition Scale: pristine

Last Fire: long unburnt

Disturbance: none

Aspect: E

Soils: brown sandy-loam

Landform: hill top

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Cover: Sparse	Cover: Moderate	Cover: Thick
Overstorey	*Eucalyptus spp.*	-m	-	<20%	-	-
Midstorey	*Eucalyptus spp.* seedlings, *Acacia* sp.	-m	-	-	20-60%	-
Understorey	*Triodia* sp.	-m	-	-	20-60%	-

Ground Cover

Bare Ground:	20-60%	Grasses:	20-60%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Stony	Peeling Bark:	0
Pebbles/Stones (0-200mm):	70-100%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	0	Water Presence:	0
Boulders:	0	Distance to Water:	0.5-2km
Caves:	Absent	Termite Mounds:	0
Suitability for Bats:	No	Woody Debris:	moderate

Bird Species

Habitat Assessment – HA11

Date: 09/10/2014
Broad Fauna Habitat:
UTM Co-ordinates 51 Easting: 0198756 Northing: 7579272

Condition Scale: pristine

Last Fire: long unburnt

Disturbance: none

Aspect: n/a

Soils: red-brown sandy-loam

Landform: gorge

Stratum	Vegetation Species	Average Height	Cover: Scattered Plants	Sparse	Moderate	Thick
Overstorey	*Acacia* sp. (large leaves), *Eucalyptus spp.*	-m	<5%	-	-	-
Midstorey	*Acacia* sp.	-m	<5%	-	-	-
Understorey	*Triodia* sp.	-m	-	-	20-60%	-

Ground Cover

Bare Ground:	60-100%	Grasses:	20-60%
Rock:	60-100%	Herbs:	<5%
Leaf Litter:	<5%	Other:	<5%
Logs:	<5%		

Microhabitats

Burrowing Suitability:	Rock	Peeling Bark:	Rare
Pebbles/Stones (0-200mm):	30-70%	Small Tree Hollows (<10mm diameter)	0
Exfoliating Slabs:	0-30%	Large Tree Hollows (>10mm diameter)	0
Rock Crevices:	30-70%	Water Presence:	Present
Boulders:	0-30%	Distance to Water:	<0.5km
Caves:	present	Termite Mounds:	0
Suitability for Bats:	yes	Woody Debris:	rare

Bird Species

Painted Finch

Diamond Dove

Willie Wagtail

Spinifex pigeon

APPENDIX E

Fauna Survey Records

Survey Species Records						
Species name	Common name	No. recorded	Site	Trap Type	Date	Time
Dasykaluta rosamondae	Kaluta	1	Site 1	Pit	6/10/2014	Day am
Diporiphora valens	Southern Pilbara Tree Dragon	1	Site 1		3/10/2014	Day am
Diporiphora valens	Southern Pilbara Tree Dragon	1	Site 1	Pit	5/10/2014	Day am
Heteronotia binoei	Bynoe's Gecko	1	Site 1		3/10/2014	Day am
Heteronotia binoei	Bynoe's Gecko	1	Site 1	Pit	5/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 1		2/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 1	Pit	4/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 2	Pit	1/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 2	Pit	2/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 2	Pit	5/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	2	Site 2	Pit & Funnel	5/10/2014	Day pm
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	3	Site 2	Pit	2/10/2014	Day
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 2	Pit	3/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 2	Pit & Funnel	3/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 2	Funnel	4/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 2	Funnel	8/10/2014	Day am
Diplodactylus savagei	Yellow-spotted Pilbara Gecko	1	Site 2	Pit	6/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 2		3/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 2		3/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 2	Pit	4/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 2	Funnel	8/10/2014	Day am
Heteronotia binoei	Bynoe's Prickly Gecko	1	Site 2	Pit	4/10/2014	Day am
Heteronotia binoei	Bynoe's Prickly Gecko	1	Site 2	Funnel	8/10/2014	Day am
Lucasium wombeyi	Pilbara Ground Gecko	1	Site 2	Pit	2/10/2014	Day
Morethia ruficauda	Lined Firetail Skink	1	Site 2	Funnel	3/10/2014	Day pm
Pseudomys desertor	Desert Mouse	2	Site 2	Pit	4/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 2	Pit	5/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 2	Pit	6/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 2	Elliott	8/10/2014	Day am
Varanus acanthurus	Ridge-tailed Monitor	1	Site 2	Pit	3/10/2014	Day pm
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 3	Pit	6/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 3	N/A	6/10/2014	Night 7pm
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 3	Funnel	7/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 3	Funnel	7/10/2014	Day pm
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 3	Pit	2/10/2014	Day
Ctenotus pantherinus	Leopard Ctenotus	1	Site 3	Pit	2/10/2014	Day
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 3	Funnel	4/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 3	Funnel	8/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 3	Funnel	5/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 3	Pit	6/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 3	Pit	2/10/2014	Day
Delma pax	Peace Delma	1 dead	Site 3	Funnel	6/10/2014	Day am
Diplodactylus pulcher	Fin-faced Gecko	1	Site 3	Funnel	8/10/2014	Day am
Diplodactylus savagei	Yellow-spotted Pilbara Gecko	1	Site 3	Pit	4/10/2014	Day am
Heteronotia binoei	Bynoe's Prickly Gecko	1	Site 3	Pit	5/10/2014	Day am
Lucasium wombeyi	Pilbara Ground Gecko	1	Site 3	Funnel	6/10/2014	Day pm
Morethia ruficauda	Lined Firetail Skink	1	Site 3	Pit	2/10/2014	Day
Ningaui timealeyi	Pilbara Ningaui	1	Site 3	Pit	2/10/2014	Day
Ningaui timealeyi	Pilbara Ningaui	1	Site 3	Pit	4/10/2014	Day am
Acanthophis wellsi	Pilbara Death Adder	1	Site 4	Pit	6/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 4	Pit	5/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 4	Pit	3/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 4	Pit	3/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 4	Pit	6/10/2014	Day pm
Delma elegans	Pilbara Delma	1	Site 4	Pit	3/10/2014	Day am

Diplodactylus savagei	Yellow-spotted Pilbara Gecko	1	Site 4	Pit	3/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 4	N/A	6/10/2014	Night; spotlighting
Heteronotia spelea	Desert Cave Gecko	1	Site 4	Pit	3/10/2014	Day am
Heteronotia spelea	Desert Cave Gecko	1	Site 4	N/A	6/10/2014	Night; spotlighting
Pseudomys chapmani	Western Pebble-mouse	1	Site 4	Pit	4/10/2014	Day am
Carlia munda	Shade-litter Rainbow Skink	1	Site 5	Sighting	5/10/2014	Day pm
Carlia munda	Shade-litter Rainbow Skink	1	Site 5	Pit	7/10/2014	Day pm
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 5	Pit	5/10/2014	Day am
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 5	Pit	8/10/2014	Day pm
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 5	Pit	9/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	4	Site 5	Pit & Funnel	3/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 5	Funnel	5/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 5	Pit	6/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 5	Pit	7/10/2014	Day pm
Gehyra pilbara	Pilbara Dtella	1	Site 5	Pit	5/10/2014	Day am
Gehyra variagata	Tree Dtella	1	Site 5	Spotlighted	8/10/2014	Night; spotlighting
Heteronotia spelea	Desert Cave Gecko	1	Site 5	Pit	5/10/2014	Day am
Pseudomys desertor	Desert Mouse	1	Site 5	Pit	3/10/2014	Day am
Varanus acanthurus	Ridge-tailed Monitor	2	Site 5	Pit & Funnel	4/10/2014	Day pm
Varanus caudolineatus	Stripe-tailed Monitor	1	Site 5	Funnel	3/10/2014	Day am
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon	1	Site 6	Pit	5/10/2014	Day am
Ctenotus nigrilineatus	Black-lined Ctenotus	2	Site 6	Pit	4/10/2014	Day pm
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 6	Pit	5/10/2014	Day am
Ctenotus nigrilineatus	Black-lined Ctenotus	1	Site 6	Pit	8/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 6	Funnel	4/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 6	Pit	7/10/2014	Day pm
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 6	Pit	8/10/2014	Day am
Ctenotus saxatilis	Stony-soil Ctenotus	1	Site 6	Pit	8/10/2014	Day pm
Delma pax	Peace Delma	1	Site 6	Pit	4/10/2014	Day am
Delma pax	Peace Delma	1	Site 6	Pit	6/10/2014	Day am
Diplodactylus savagei	Yellow-spotted Pilbara Gecko	1	Site 6	Pit	4/10/2014	Day pm
Diporiphora valens	Southern Pilbara Tree Dragon	1	Site 6	Pit	6/10/2014	Day pm
Diporiphora valens	Southern Pilbara Tree Dragon	1	Site 6	Pit	9/10/2014	Day pm
Gehyra variagata	Tree Dtella	1	Site 6	N/A	4/10/2014	Night; spotlighting
Gehyra variagata	Tree Dtella	1	Site 6	Pit	10/10/2014	Day am
Morethia ruficauda	Lined Firetail Skink	1	Site 6	Pit	7/10/2014	Day pm
Ramphotyphlops grypus	Long-beaked Blind Snake	1	Site 6	Pit	5/10/2014	Day am
Ramphotyphlops grypus	Long-beaked Blind Snake	1	Site 6	Pit	10/10/2014	Day am
Varanus acanthurus	Ridge-tailed Monitor	1	Site 6	Funnel	4/10/2014	Day pm

APPENDIX F

Photographs of Non Conservation Significant Fauna

Acanthophis wellsei Pilbara Death Adder

Acanthophis wellsei Pilbara Death Adder

Ctenophorus caudicinctus Ring-tailed Dragon

Ctenotus saxatilis Stony-soil Ctenotus

Delma pax Peace Delma

Gehyra pilbara Pilbara Dtella

Heteronotia spelea Desert Cave Gecko

Lucasium wombeyi Pilbara Ground Gecko

Veranus acanthurus Ridge-tailed Monitor

Veranus caudolineatus Stripe-tailed Monitor

Amytornis striatus Striated Grasswren

Haliastur sphenurus Whistling Kite

Ningaui timealeyi Pilbara Ningaui

APPENDIX G

Acoustic Bat Report

Nullagine fauna survey
Pilbara WA,
October 2014

Echolocation Survey of Bat Activity.

Prepared for 360 Environmental Pty Ltd

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Issue 1
11 February 2015

Document Revision History

Date	Issue	Revision History
14 Oct 2014	Issue A	Initial draft prepared for 360 Environmental
11 Feb 2015	1	First formal issue

Summary
Microbat species presence, with an estimate of activity level, is presented for ten recording nights at Nullagine in the Pilbara, WA. 360 Environmental (“360”) carried out an echolocation based survey during October 2014. Bat Call WA has reviewed the recordings made and provided species lists for the bats present.

Eight species of echolocating microbats were recorded including the EPBC Act listed Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (PLNb). No Ghost Bat (*Macroderma gigas*) calls were detected.

Habitats
Nine sites were chosen by “360”. Details of the sites are presented in Table 1. Five are on creek lines and three are on a hill with breakaways and historic underground workings. The locations of the sites are shown in relation to the locality’s features in Figure 1.

Characteristics of the calls recorded are presented in Table 2.

Bat Fauna
A microbat assemblage of eight insectivorous species was confirmed as present at the study sites including the PLNb, Tables 2 and 3. Each of the insectivorous species is has previously been detected in the district. Species activity levels were low to high, which is expected for the study area habitat and the time of year, see criteria below.

The Pilbara leaf-nosed bat, listed as Vulnerable under Commonwealth legislation, was detected in low numbers at two sites, Table 3 and Figure 1. It has previously been detected in the district at at least two locations to the northeast and southwest of Nullagine on the Nullagine River (McKenzie and Bullen 2009). This current detection in October, at the end of the dry season, suggests that the bats are originating from a previously unknown roost that is in the Nullagine district rather than at the Copper Hills mine. That well documented roost is approximately 30 km north of the study area, a distance that is thought to be beyond the late dry season flying range of the PLNb (Bullen 2013).

Survey Timing, Moon Phase and Weather
The survey was conducted between 4th and 9th October 2014. Sampling evenings were hot and dry with minimum overnight temperatures between 20 and 25^{O}C. The moon in this period was full. These conditions correspond to typical levels of bat echolocation detection for the season.

Survey Team
A team of “360” ecologists conducted the bat sampling work. Bob Bullen of Bat Call WA completed analysis of echolocation recordings.

Sampling
The survey consisted of completing a total of ten overnight bat sound recordings, beginning at twilight, at nine locations within the survey area. The recordings were “continuous” (Hyder *et al.* 2010) made using a SM2BAT SongMeter (Wildlife Acoustics Inc, USA). The jumper and audio settings used for the SM2BAT followed the manufacturer’s recommendations for bat detection contained in the user manual

(Wildlife Acoustics 2010). Selectable filters and triggers were also set using the manufacturer's recommendations, see also Table 4. Table 2 provides details of the methods used by date and site.

For the recordings, once reformatted as .wav files, COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.) was used to display each sequence for identification. Calls were identified manually. Only good quality call sequences were used. Details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006). Reference data for the species identified are available in Bullen and McKenzie 2002, McKenzie and Bullen 2003 and McKenzie and Bullen 2009.

Bat activity was then characterised as “Low”, “Medium” or “High” based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes,
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a at least an hour followed by sporadic records for the remainder of the session.
- High species activity refers to call recording more often than two minutes apart for at least two hours followed by reasonably regular records for the remainder of the session.

Survey Limitations

The sites surveyed were accessible on foot and the SM2, using an omnidirectional microphone, was set on the ground with the microphone horizontal. Species are unlikely to be under-represented as a result.

Bat species density away from cave or adit entrances is impossible to estimate from echolocation records. Bat activity is therefore substituted as an approximate guide to the relative numbers of each species using the study area.

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Table 1 Site Specific details.

Site	Date	Recording Time	Habitat	Easting	Northing
360bat-01	4 Oct	One overnight recording using SM2 SN 11793	Dry ephemeral creek line	200285	7577941
360bat-02	5 Oct	One overnight recording using SM2 SN 11793	Dry ephemeral creek line	200838	7579935
360bat-03	6 Oct	One overnight recording using SM2 SN 11793	Dry ephemeral creek line	199868	7578015
360bat-04	7 Oct	One overnight recording using SM2 SN 11793	Dry ephemeral creek line	201090	7579556
360bat-05	4 Oct	One overnight recording using SM2 SN 12801	Historic underground working adit	200022	7577008
360bat-06	5 Oct	One overnight recording using SM2 SN 12801	TBA	TBA	TBA
360bat-07	6 Oct	One overnight recording using SM2 SN 12801	Dry ephemeral creek line	199269	7577262
360bat-08	7-8 Oct	Two overnight recordings using SM2 SN 12801	Historic underground working adit	199991	7577674
360bat-09	9 Oct	One overnight recording using SM2 SN 12801	Historic underground working adit	199851	7577636

Note: All coordinates are in zone 51K

Table 2: Summary of Echolocation call characteristics for microbat species present.

Genus species Authority	Common name	Typical F_{peakC} kHz	Ave. Q	Typical Duration msec	Typical Call Shape
Chaerephon jobensis (Miller 1902)	Northern free-tailed bat	22	5	8 - 15	Shallow FM
Chalinolobus gouldii (Grey 1841)	Gould's wattled bat	32	10	7 - 11	FM
Mormopterus lumsdenae Reardon 2014	Beccari's free-tailed bat	26	10	8 - 13	Shallow FM
Rhinonicteris aurantia (Gray 1845)	Pilbara leaf-nosed bat	120	30	5 - 8	CF
Saccolaimus flaviventris (Peters 1867)	Yellow-bellied sheath-tailed bat	18	9	12 - 21	CF - FM
Scotorepens greyii (Gray 1843)	Little broad-nosed bat	38	10	7 - 13	FM
Taphozous georgianus Thomas 1915	Common sheath-tailed bat	24.5	14	9 - 18	CF– shallow FM
Vespadelus finlaysoni (Kitchener, Jones and Caputi 1987)	Inland cave bat	55	14	4 - 8	FM

Note1: FpeakC and Q are defined in McKenzie and Bullen 2003, 2009.
Note 2: *M. lumsdenae* was known as *M. beccarii* until a recent reclassification of Australian *Mormopterus* species (Reardon *et al*. 2014).

Table 3. Microbat lists obtained presented by site.

Site	Date	*Chaerephon jobensis*	*Chalinolobus gouldii*	*Mormopterus lumsdenae*	*Rhinonicteris aurantia*	*Saccolaimus flaviventris*	*Scotorepens greyii*	*Taphozous georgianus*	*Vespadelus finlaysoni*
360bat-01	4 Oct	High					Low	High	Low
360bat-02	5 Oct	High	Low	Low			Med	Low	Med
360bat-03	6 Oct	Low	Low			Low	Low	Low	High
360bat-04	7 Oct	Low	Low				Low	Low	Low
360bat-05	4 Oct						Low		High
360bat-06	5 Oct	Low	Low			Low	Low	Low	High
360bat-07	6 Oct	Low	Low			Low			Low
360bat-08	7-8 Oct				Low (3 calls)		Low	High	High
360bat-09	9 Oct	Low	Low		Low (4 calls)		Low	Med	High

Table 4 SM2 Audio settings used during survey.

Parameter	Setting
Sample rate	384,000 kHz
Channel used	Left
Compression protocol	WAC0 (12 bit audio samples)
Gain - left channel	0.00
Digital high pass filter Left channel	fs/48 (giving 8 kHz minimum frequency)
Digital low pass filter Left channel	Off
Triggering level Left channel	6SNR (adaptive +6 dB triggering)
Triggering window Left channel	1.0 sec.

Note: These settings are as recommended in Wildlife Acoustics (2010) except the high pass filter. This is set lower to 8kHz to record any *Tadarida australis* that may be present

Figure 1. Detector Sites in relation to features in the study area. Orange pins denote sites where PLNb were detected.

APPENDIX H

Targeted Pilbara Leaf-nosed Bat Survey

Novo Resources Corp.
Beatons Creek Project,
Pilbara Leaf-nosed Bat survey,
December 2014

Prepared for 360 Environmental Pty Ltd

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Document Revision History

Date	Issue	Revision History
12 Dec 2014	A	Initial draft prepared for 360 Environmental review
29 Jan 2015	1	Formal issue incorporating review comments

Executive Summary

Orange Leaf-nosed Bats, Pilbara form (*Rhinonicteris aurantia*), herein referred as Pilbara Leaf-nosed Bats (PLNb), have been detected at the Novo Resources (Novo) Beatons Creek Project, at Nullagine in the Pilbara, Western Australia (Bat Call 2014). Together with records in the Nullagine district at a small number of sites these detections suggest that a previously unknown colony of PLNb exists in the district and may be on Novo's tenements. The closest known PLNb roost is at the historical Copper Hills Mine, 28 km to the north. Other known roosts are over 75 km distant.

Bat Call WA (Bat Call) carried out an extensive dry season survey in early December 2014 utilising current industry standard bat ultrasonic detection systems to determine the presence of any PLNb diurnal roosts close to Nullagine. Overnight recordings were made at forty sites and PLNb calls were detected at twenty two.

The aims of the survey were to:

- Confirm that the PLNb at Beatons Creek are originating from a previously unknown roost nearby;
- Confirm the presence or absence of any diurnal PLNb roost within Novo's impact area and extended tenements;
- Locate as closely as possible the exact location of the PLNb diurnal roost;
- Complete a census of the bats resident therein (if a roost cave was located) as this will provide baseline information for the project's ongoing management of the species in the area; and
- Provide an initial foraging habitat assessment within the study area.

During the survey, PLNb activity was detected generally across a 20 km radius circle centred on the Beatons Creek project that includes the majority of Novo's tenements in the district. Timing of the calls detected confirms that there is a previously unknown diurnal, and possibly maternal, roost in the Nullagine district. The exact location of the colony's roost was not found but the activity levels and temporal pattern of detections show that it is not immediately adjacent to Beatons Creek or within the project's environmental envelope. The results suggest that the roost lies in one of the ridges to the south of Beatons Creek possibly within Novo's extended tenements. Confirming the status of this site as a maternity roost will require additional survey work.

In conclusion, the systematic methodology applied during this study to collect data to determine the likelihood of the location of diurnal roost cave(s) within the Beatons Creek project area provides confidence in the finding that the PLNb diurnal roost is outside the proposed footprint of the Project.

Introduction

Project Background

Novo Resources Corporation (Novo) proposes to develop the Beatons Creek project, adjacent to the township of Nullagine, as a part of its current Pilbara operations, Figure 1. The project includes a number of tenements, some of which are in close proximity to Nullagine. Novo also holds a larger tenement to the southwest of the Nullagine.

Recent surveys in the project area have detected foraging activity of the Orange Leaf-nosed bat, Pilbara form (*Rhinonicteris aurantia* referred herein as Pilbara Leaf-nosed Bat or PLNb, see Armstrong 2006; previously J.E. Gray, 1845), (Bat Call 2014; 360 Environmental 2015). The PLNb is listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation* (*EPBC) Act 1999*. In Western Australia (WA) it is listed as a Schedule 1 species under the *Wildlife Conservation Act 1950*.

Novo commissioned 360 Environmental (with Bat Call WA [Bat Call] subcontracting) to undertake a regional study of PLNb activity including Novo's tenements for PLNb conservation values. The study area was a 20 km circle centred on Nullagine that encompassed the project area and the adjoining Novo tenements. If possible the colony's roost was also to be located.

Figure 1: General Arrangement of Novo's tenements (in red) highlighting the location of the Beatons Creek Project immediately northwest of Nullagine. The white 20 km radius circle indicates the area suggested as the location of a previously unknown PLNb diurnal roost by recent surveys within the district. The location of the closest known diurnal/maternity roost is at Copper Hills mine, 28 km to the north of Nullagine. The closest known colonies to the east and west are over 75 km distant.

Climate

The climate of the Pilbara region of WA is classified as arid tropical with two distinct seasons: a hot wet summer (October to April) and a mild dry winter (May to September). During the summer, heat-generated low pressure systems dominate the inland Pilbara region generating intermittent thunder storms. Tropical cyclones develop over warm tropical waters of the Indian Ocean to the north and west between December and April. These often track southwest along the Pilbara coast, or turn inland across the Pilbara bringing destructive winds, widespread rain and flooding (Payne and Tille, 1992). During winter the passage of high pressure systems to the south often produce easterly winds and some precipitation over the inland Pilbara (Van Vreeswyk *et al*., 2004).

Based on 107 years of data from the nearest weather station at Nullagine the mean annual rainfall is 335 mm, with very high seasonal and annual variability (Bureau of Meteorology [BOM], 2014). The mean maximum temperatures at Nullagine are above 30˚C for eight months of the year and exceed 35˚C during the months of November to March. Mean maximum temperatures drop below 30˚C during the months of May to August. Minimum overnight temperatures exceed 15˚C for all but these cooler months.

Topography and Geology

The study area occurs within the Interim Biogeographic Regionalisation for Australia (IBRA) PIL1 Chichester subregion of the Pilbara bioregion. It is located in the north-eastern section of the Pilbara Craton and characterised by Archean basaltic mountainous areas of the Fortescue group, dissected by gorges, and plains and low hills of the Mosquito Creek formation. The ranges are dominated by *Eucalyptus* spp. over *Triodia* spp. (spinifex - hummock grasses) (Kendrick and McKenzie, 2001). The plains support a shrub steppe characterised by *Acacia* spp. over *Triodia* spp.

The Beatons Creek project and the ridges to the west are dominated by Fortescue Group strata. The plains to the east within the Mosquito Creek formation include a number of historical mines with numerous adits and shafts of varying depth. The higher western ridges are incised with steep sided gullies and gorges of varying depth. Observations made during the study confirm that the area contains many shallow overhangs and deeper shelters. Cave density was assessed as low with few deep caves present based on our survey experience in this and adjoining areas.

Surface Water

The ranges contain permanent and semi-permanent pools on the Nullagine River and its tributaries. These include the Taylor, Beatons and Bonnie Creeks in the study area. Numerous ephemeral creek lines with pools cross the plains to the east including Five Mile, Cajuput and Middle Creeks. In addition there are a series of artesian water-points with permanently open tanks and ponds for cattle watering.

Historical Mining Operations

Open-cut and underground mining operations have been underway for many years in the Nullagine district. These underground operations are typically small scale with access by shallow shafts. Some of these intersect the water table and may have lateral tunnels below ground.

Approximately 28 km north of Nullagine is the known PLNb diurnal/maternal roost at the abandoned Copper Hills mine. This colony has been estimated to contain over 500 PLNb (Bob Bullen unpublished data).

Bats of the Pilbara

The Pilbara region contains 17 species of Microchiropteran bat (microbat). Of these, 13 have the potential to be found in the Chichester subregion (Van Dyck and Strahan, 2008; McKenzie and Bullen, 2009). Only the PLNb (a small 10 g insectivore) is of National environmental significance and as such, is listed under the EPBC Act. The PLNb is endemic to northern Australia. The Pilbara population is isolated from the main tropical population by the uninhabitable arid zone to the north and east. The Pilbara population is semi-desert adapted and has specific roosting requirements that involve temperature and humidity.

Data from Recent Surveys

The PLNb was detected at the Beatons Creek Project in October 2014 (360 Environmental 2015). There are few other previous records of this bat within or adjacent to the study area (Table 1).

Table 1: Summary of Pilbara Leaf-nosed Bat records near-by the Beatons Creek Project.

Date	Record Description	Method	Reference	Location
	Unknown		DPaW NatureMap	Approximately 10 km east of Nullagine
2005	Echolocation record of foraging activity	Anabat detector	McKenzie and Bullen (2009)	On the Nullagine River 10 km northeast of Nullagine.
2010	Echolocation records of foraging activity	Anabat detector	Ninox (2011)	At Barton Mine 18 km east of Nullagine.
2012	Echolocation records of foraging activity	Anabat detector	Metcalf and Bamford (2013)	At caves near Bonnie Creek 15 km southwest of Nullagine.

The Pilbara Leaf-nosed Bat

The PLNb is listed as Vulnerable by the Commonwealth *EPBC Act*. It is also listed as Schedule 1 (fauna that is rare or likely to become extinct) under the WA *Wildlife Conservation Act 1950*. This species listing is on the basis of the impact to habitats providing suitable roosts with the correct microclimate. It is a geographically isolated form of the tropical populations of Orange Leaf-nosed Bat, being separated by approximately 400 km of the Great Sandy Desert. The PLNb is known solely from the Pilbara and Ashburton bioregions of WA. The few known roosts are concentrated in caves in gorge systems and disused mines in the eastern Pilbara, in the Hamersley Ranges and in Barlee Nature Reserve (DoE, 2014).

The PLNb is an acrobatic, high-energy flyer that forages for its prey along the gorges and ridgelines around its roost. It is most often observed in flight over water holes or flying along road easements approximately 1-2 m from the ground (Churchill, 2008). McKenzie and Bullen (2009) characterise its “mode” flight speed (*i.e.* the speed most often measured during free flight) as 6.1 $m.s^{-1}$ (22 kph). Bat Call's unpublished data shows that speeds up to 20 kph are commonly used while dispersing from the diurnal roosts. Bat Call's unpublished data also shows the species to be capable of level flight speeds in excess of 8.6 $m.s^{-1}$ (31 kph) while commuting to and from distant sites.

Foraging habitat for the PLNb is diverse. The species generally hunts with a manoeuvrable flight through cluttered airspace including riparian vegetation in gorges, and over hummock grassland and tree and shrub savannah (Duncan *et al*., 1999; Woinarski *et al*., 2014). In the Pilbara, it has been observed in *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (Armstrong, 2001; Churchill *et al*., 1988). It has also been recorded over small watercourses amongst granite boulder terrain; over pools and low shrubs in ironstone gorges; and above low shrubs and around pools in gravely watercourses with *Melaleuca leucodendron*, such as in the Barlee Range Nature Reserve (Armstrong, 2001). It is often detected foraging in the entrances of caves and shelters (author's unpublished data).

Documented PLNb roosts contain relatively small numbers ranging from a few individuals to a few hundred, and based on published data a typical Pilbara roost site appears to be 30 based (DoE, 2014). Recent census work at several roosts in natural caves suggests that several hundred to 1,500 is a more typical figure (Bat Call WA, unpublished data). One roost in the Western Hamersley ranges contains many thousand (Bullen 2013).

Across northern Australia, the tropical form of the Orange Leaf-nosed Bat is reliant on roost sites in caves or mine adits with stable, very hot (28–32°C) and very humid (96–100%) microclimates (Churchill 2008). This is a result of their limited ability to conserve heat and water (Churchill, 1991; Armstrong, 2001). Caves and abandoned mines deep enough to create this environment are relatively uncommon in the Pilbara (Van Dyck and Strahan, 2008), which limits the availability of diurnal roosts for this species. The PLNb is subject to rapid dehydration and death within a day if removed from a roosting location with this type of microclimate (Churchill 2008). The closest known roost to the Beatons Creek project area is 28 km to the north at Copper Hills Mine. The closest known roosts to the east, west and south are over 75 km distant. Additionally, PLNb roosts located to date, all have an association with permanent water pools within a short flying distance of approximately 5 km (Bat Call WA, unpublished data).

PLNb are now known to depart and return to diurnal roosts at specific times of the night following a seasonal pattern. Long term monitoring data from several known PLNb colonies (Bat Call unpublished data) supported by data from other roost caves shows that during the dry season the bats begin to depart their roost within a few minutes of civil twilight on the majority of nights (Bullen 2013). This occurs unless there are overcast conditions which lower evening light levels or other situations which increase light levels. Consequently the bats begin to depart earlier in lower light, particularly during heavy overcast conditions, and later in higher light level conditions, particularly during summer electrical storms. They then disperse over their foraging range typically using flight speeds up to their mode cruise speed of approximately 20 kph, returning before civil twilight in the morning (Bat Call unpublished data).

The species is known to have a typical dry season foraging range of 15-20 km from its primary roost caves (Bullen 2013). It does forage at greater distances if suitable water sources are available (Bat Call WA, unpublished data). It also appears to range nomadically from these roosts when wet season conditions allow it to use alternative caves and other roosts (Bullen and McKenzie 2011). It is not known if these foraging ranges apply to males and females equally.

Scope of Work

The scope of work for the project was to:

- Confirm that the PLNb at Beatons Creek are originating from a previously unknown roost nearby;
- Confirm the presence or absence of any diurnal PLNb roost within Novo's impact area and extended tenements;
- Locate as closely as possible the exact location of the PLNb diurnal roost;
- Complete a census of the bats resident therein (if a roost cave was located) as this will provide baseline information for the project's ongoing management of the species in the area; and
- Provide an initial foraging habitat assessment within the study area.

Methodology

Survey Team

The survey team consisted of Mr Robert Bullen of Bat Call WA and Dr Ron Firth of 360 Environmental.

Survey Timing and Weather

The field trip was undertaken between 1st and 7th December 2014. The weather was very hot and dry during the day followed by hot evenings typical of late dry season weather. Daytime temperatures were approximately 45^{o}C and minimum night time temperatures were around 30^{o}C. Sunset/rise times during the survey were within two minutes of 18:31 and 05:08. Similarly civil twilight times were within two minutes of 18:56 and 04:43. The moon was between first quarter and full during this period.

Site Selection and Foraging Habitat Assessment

Sites for echolocation recording were selected to address the first three objectives of the study in order (Figure 2). These were within a 25 km radius of Nullagine and included all of Novo's tenements. Sites were selected based on the likelihood that the PLNb would be either foraging at, or commuting past, the location, should they be present. Initially southern sites were selected to determine that the PLNb were not originating from Copper Hills Mine roost to the north. Sites were then selected based on the initial results in an effort to locate the roost. The most distant sites to the east and west were to ensure that no additional roost was located near the study area. Access into Novo's southern tenement, and therefore the number of sites that could be sampled, was limited to the available 4WD tracks into the ranges south and west of Nullagine.

An assessment of PLNb foraging habitat was undertaken at each detector site. The assessment was based on Bat Call WA's unpublished observations of the species collected over 15 years. Each site was characterised against a numerical scale with a range of zero (no activity expected) to five (very high activity levels immediately adjacent to a roost). Definitions are in Appendix A.

Bat Echolocation Recordings

Echolocation call data were collected at 40 sites within the study area (Figure 2). At one site, 3N23, detectors were placed in eastern and western branches of an ephemeral creek line designated as '23A and '23B respectively.

Full spectrum ultrasonic bat detectors (SM2BAT+, 384 kHz, models Wildlife Acoustics, USA) were used to observe and record bat activity. The settings used on each SM2 detector are shown in Appendix B. The detectors were deployed for a single night at each location and the data obtained were reviewed daily. PLNb presence was confirmed by recording of distinctive diagnostic ultrasonic calls at the sites.

The SM2BAT recordings, once reformatted as .wav files, were reviewed using COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.). This displayed each call sequence with information on the number and timing of calls. Bat activity levels were then assessed from the identified PLNb calls (Table 2).

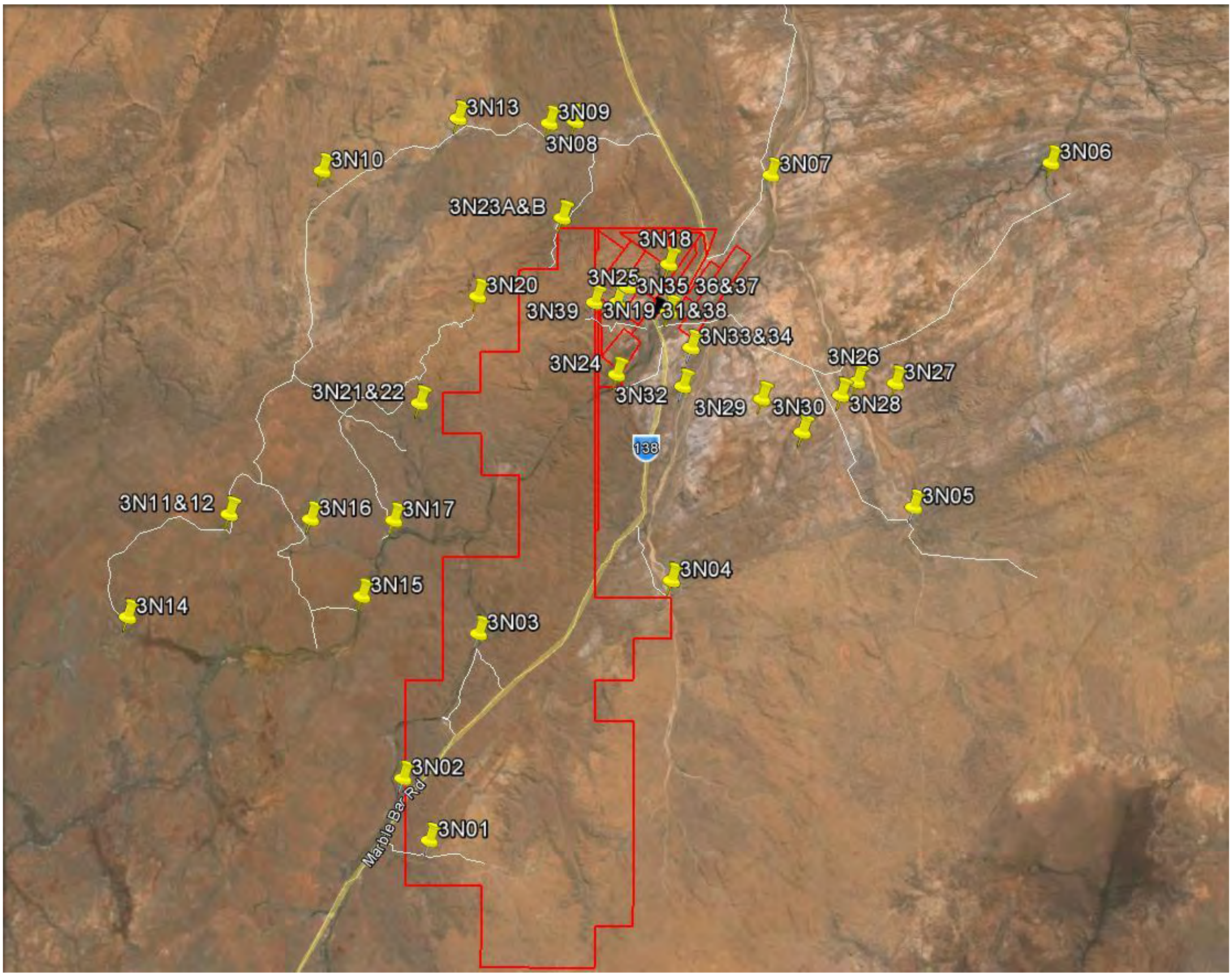


Figure 2: Bat echolocation locations within the study area. The sites selected for assessment are numbered 3N01 to 3N39 (note that 3N23 has site A and site B nearby). The red outline indicates Novo's tenements in the district. The 4WD tracks providing access to the study area are indicated by the white lines.

Table 2: Criteria for characterising bat activity levels.

Bat Activity Rating	Criteria
Low	Species is recorded with call spacing greater than ten minutes.
Medium	Species is recorded with call spacing of less than 10 minutes but greater than 2 minutes. This pattern is observed for at least an hour followed by sporadic records for the remainder of the session.
High	Species is recorded with call spacing less than 2 minutes apart for at least two hours followed by regular records for the remainder of the session.

Note: activity levels show a measure of the number of bat passes. They do not directly provide a guide to the usage of the site as a roost, forage location, commute site, etc. or accurate abundance data. However, data may be used to assist in inferring such results.

Survey Limitations

The primary objective of the survey was the characterisation of PLNb activity within and adjacent to the Beatons Creek project area and adjacent tenements (figure 2). All aspects of the survey except for tenement access, i.e. team make-up and experience levels, equipment used including bat detectors (provided by Bat Call) and 4WD vehicles, logistics and safety support (provided by 360 Environmental) were suitable for the task. Access to the majority of the southern and western tenement areas of the study area was not generally possible using 4WD vehicles. Limited access was able to be gained to the periphery of this tenement using available tracks. Access by foot into this tenement was impossible due to the distances and extreme heat encountered during the survey.

No interior searches of caves were carried out. No activities were undertaken that could cause harm to the bats present.

Abundance estimates of the PLNb at the sites are impossible to calculate from ultrasonic recordings due to the possibility of multiple passes by individual bats. Instead, activity levels were documented based on the criteria above (Table 2).

Results

PLNb were detected at 22 of 40 sites during the study (Figure 3). A broad pattern of calls is evident in the data with detections being made to the north, east, south and west of the project area. This is centred on Nullagine at the northern end of the Novo's tenements. No sites produced High activity levels and Medium level activity was recorded at four sites (120, 58, 18 and 15 calls at sites 3N08, '13, '14 and '25 respectively). Low activity was recorded at the other eighteen sites with nightly call totals between one and six and no detections were made at eighteen sites. No detections were made in the southern third of Novo's tenements.

The temporal pattern of detections at each site (Figure 4) begins approximately 50 minutes after sunset (the earliest call detected being at 1922 hours at site 3N30) and the latest call detected was approximately 40 minutes before sunrise, being at 0427 hours at site 3N25. These patterns are all consistent with nightly foraging and do not indicate a roost in close proximity.

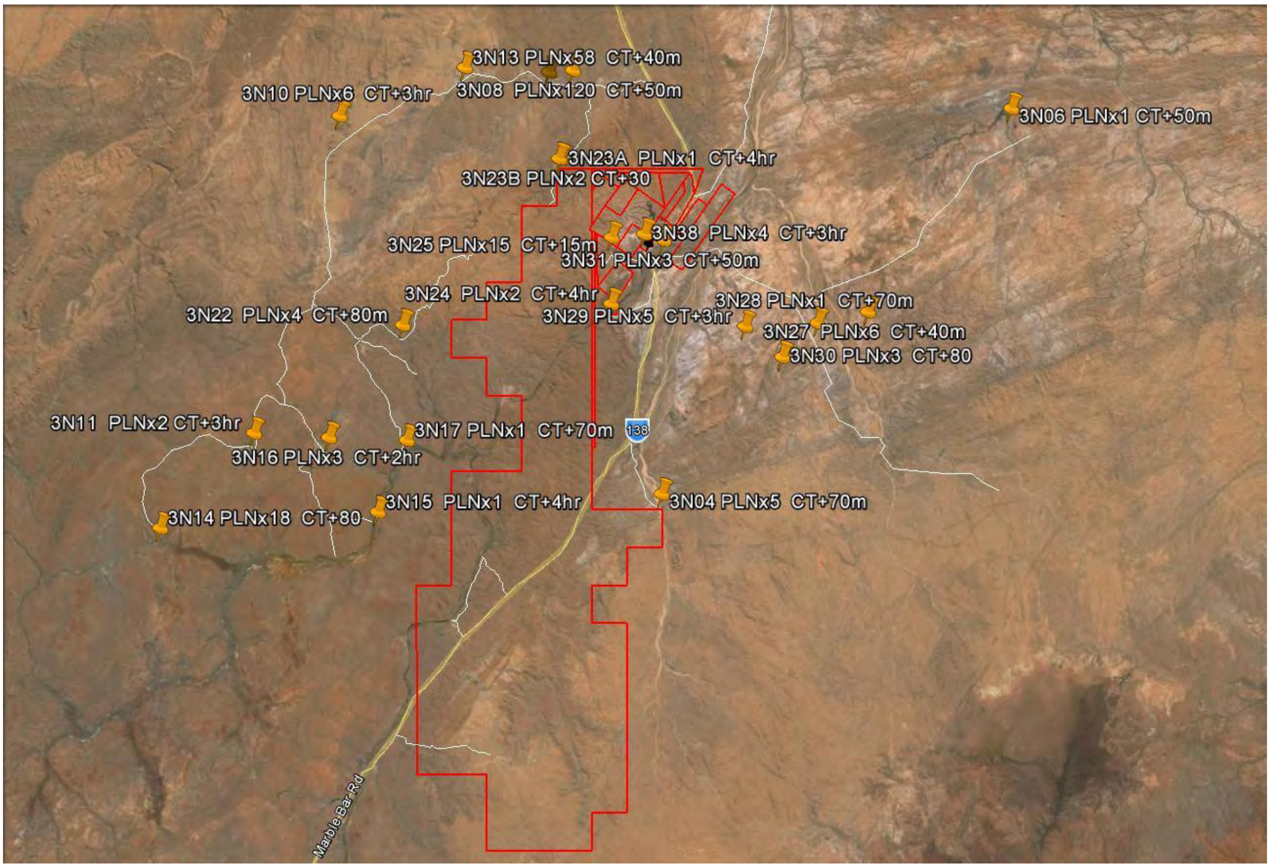
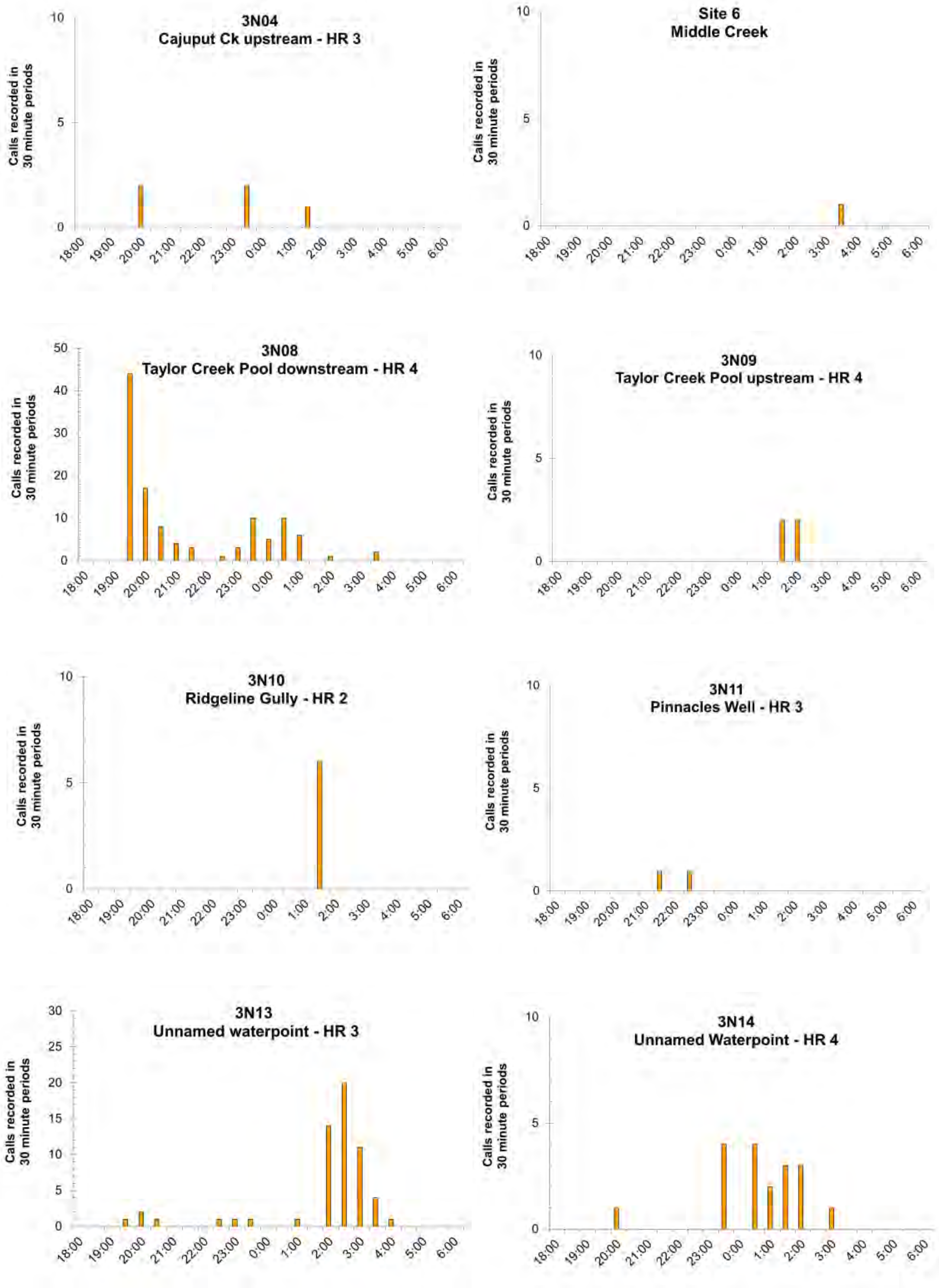
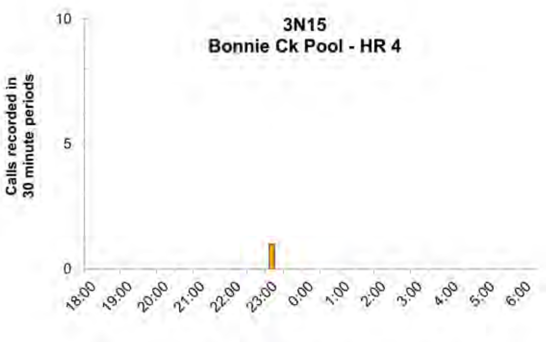
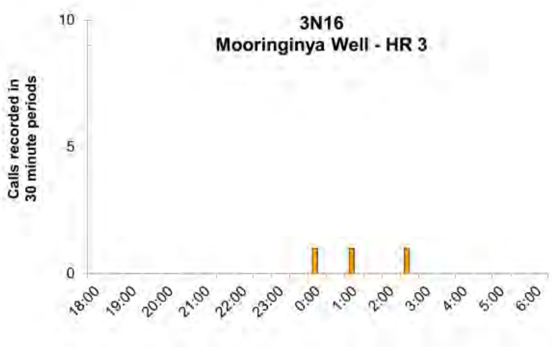


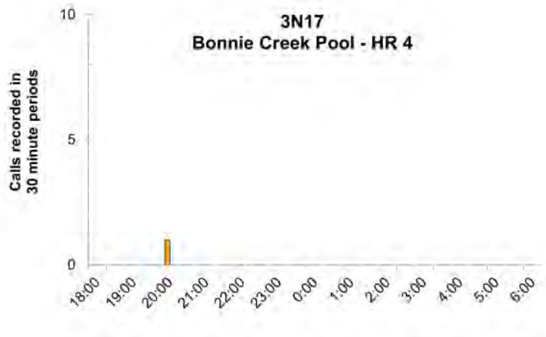
Figure 3. Location of Pilbara Leaf-nosed Bat detections. The number of calls detected and the time differential between the earliest and latest detections and civil twilight are shown.

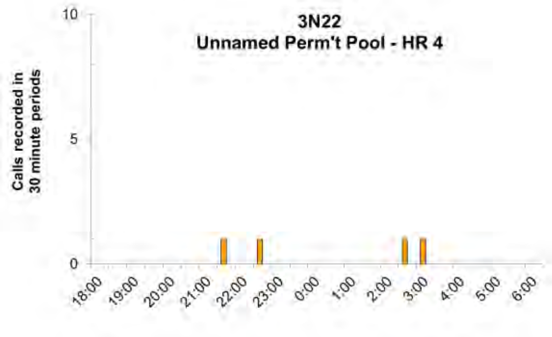
Figure 4. Series of graphs depicting the temporal pattern of Pilbara Leaf-nosed Bats calls recorded. On each graph the site number, a short description and its habitat rating are given.

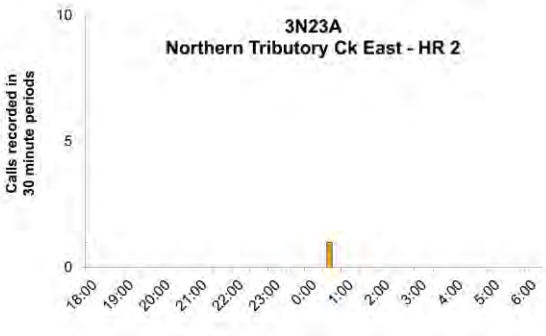


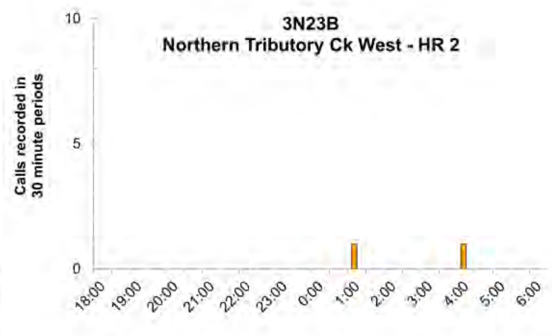

3N15
Bonnie Ck Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

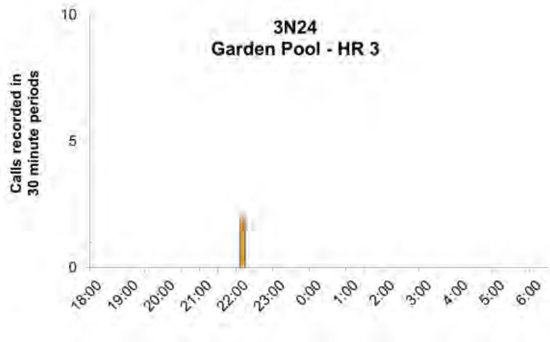

3N16
Mooringinya Well - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

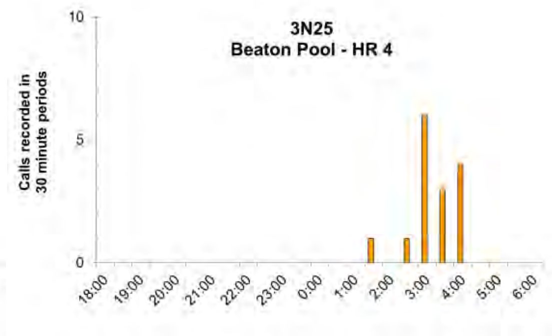

3N17
Bonnie Creek Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

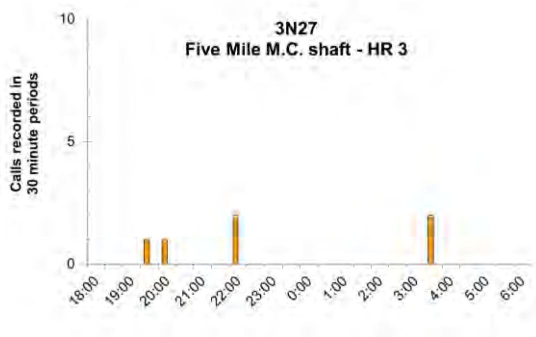

3N22
Unnamed Perm't Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

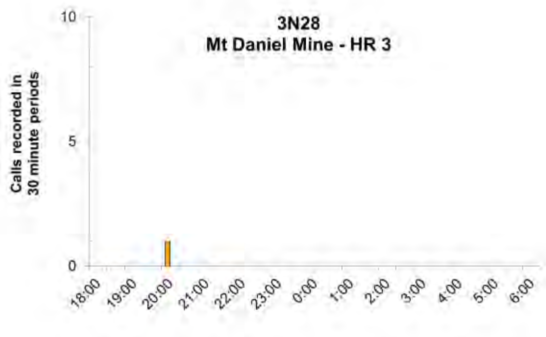

3N23A
Northern Tributory Ck East - HR 2
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

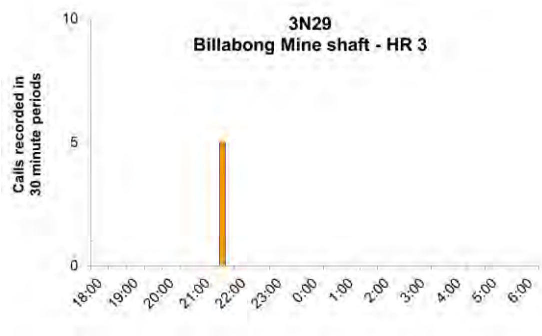

3N23B
Northern Tributory Ck West - HR 2
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

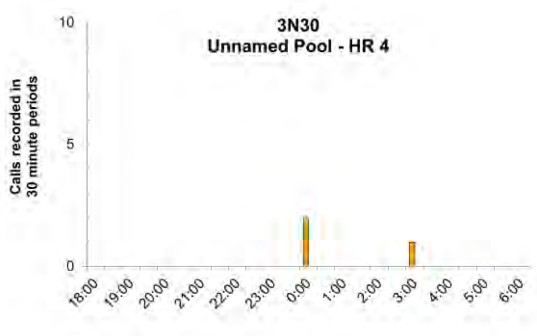

3N24
Garden Pool - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

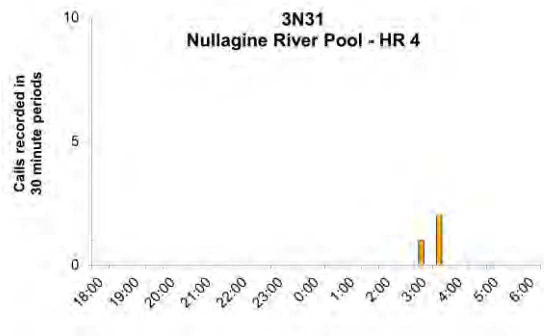

3N25
Beaton Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

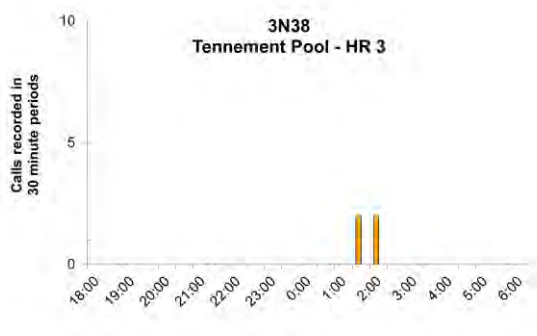

3N27
Five Mile M.C. shaft - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00


3N28
Mt Daniel Mine - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00


3N29
Billabong Mine shaft - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00


3N30
Unnamed Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00


3N31
Nullagine River Pool - HR 4
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00


3N38
Tennement Pool - HR 3
Calls recorded in 30 minute periods
10
5
0
18:00 19:00 20:00 21:00 22:00 23:00 0:00 1:00 2:00 3:00 4:00 5:00 6:00

Confirmation that the Nullagine PLNb roost is a previously unknown colony

Proof that the PLNb detected during the study originate from a previously unknown colony is provided by detections close to civil twilight at six sites, Figure 5. The theoretical flying range from the diurnal roost at 20 kph in each case is well short of the distance to the closest known roost at Copper Hill Mine (Figure 5). In five of the six cases the range at 30 kph is also well short of the distance to that mine. The exception is site 3N14 where the radial distance from Copper Hills is over 40 km which is well beyond the distance that bats originating from that mine would be expected to fly in the late dry season.

No data were collected that confirms (or otherwise) the status of the colony as a maternity roost or a seasonal diurnal roost.

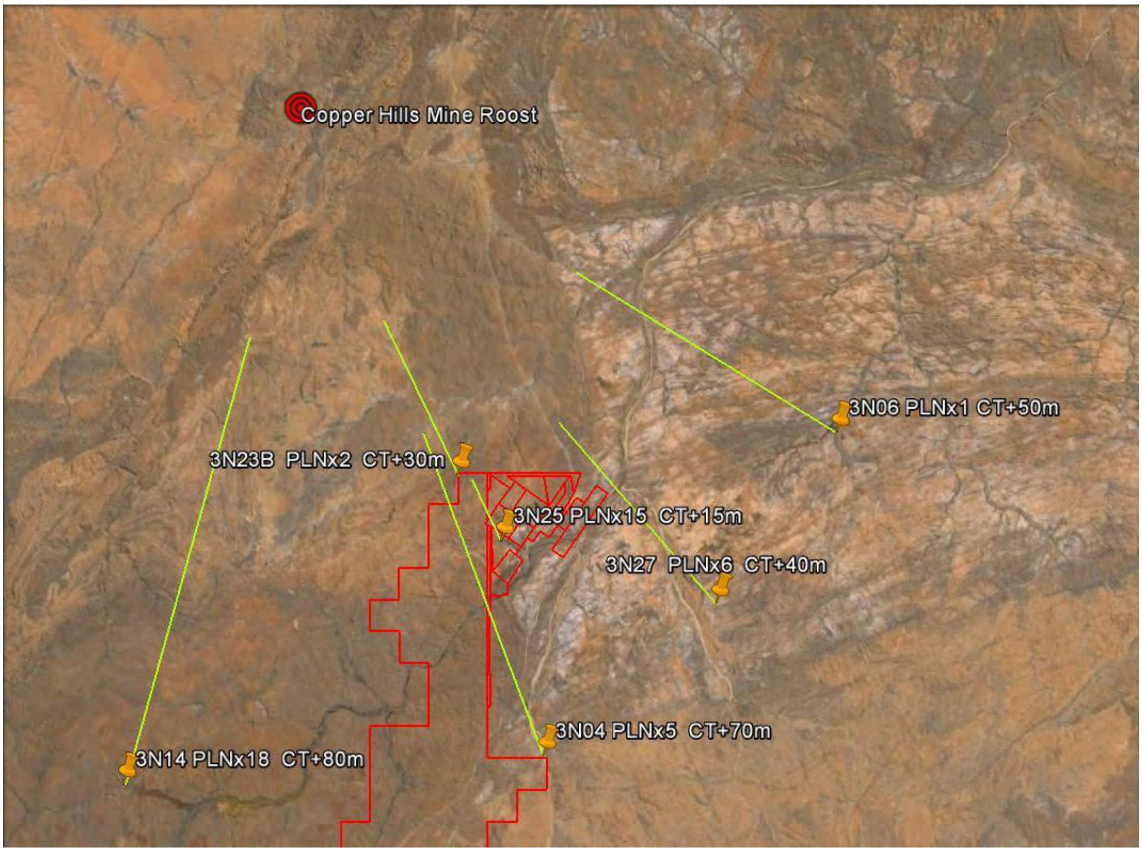


Figure 5. A selection of PLNb detection sites that show that the theoretical flying range to a diurnal roost at 20 kph (green rays) does not approach the Copper Hills roost. This proves that the PLNb detected during the study do not originate from that mine. Other known roosts are over 75 km distant.

Confirmation that the Nullagine PLNb roost is not within Novo's impact area

Results at 14 sites within 5 km of the project impact area indicate that the new diurnal roost does not lie in that zone (figure 6). Nine sites had no detections despite being preferred foraging locations with habitat ratings between 2 and 4 (see below). Of these, 5 were deep historical adits or shafts (3N33, '34, '35, '36 and '37), two were permanent pools (3N07 and '18) and two were preferred foraging locations with ephemeral water close by (3N19 and '39). Three sites close to the impact area had low detection numbers and timing that was 50 minutes or more after/before twilight (3N24, '31 and '38). Two had calls detected within 30 minutes of twilight but the theoretical flying ranges in both cases could be explained by a roost outside the impact zone. If the roost was within the zone, the number of detections would be expected to be much higher and the timing of the earliest/latest calls would be typically closer to twilight.

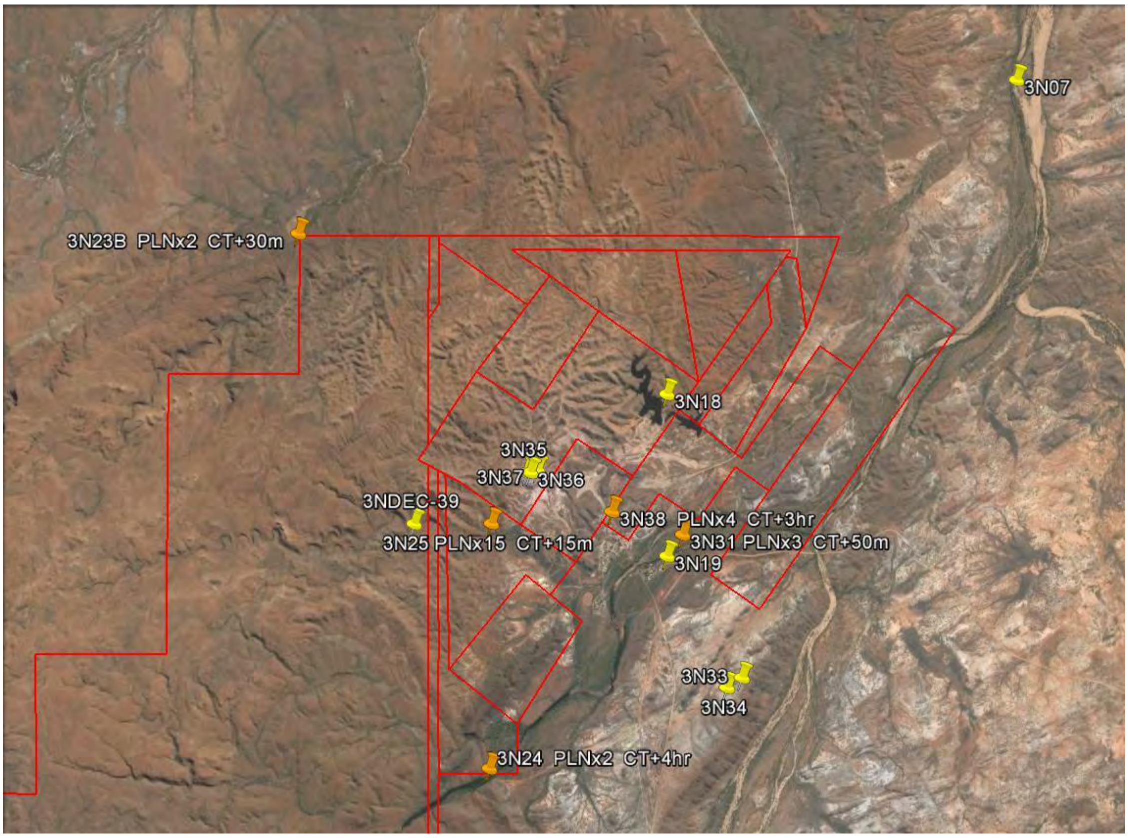


Figure 6. Results at 14 sites within 5 km of the project impact area. Orange and yellow pins denote sites with and without PLNb detections respectively. Nine sites had no detections despite being preferred foraging locations with habitat ratings between 2 and 4. Three sites close to the impact area had low detection numbers and timing that was well after/before twilight. Two had calls detected within 30 minutes of twilight but the theoretical flying ranges in both cases was not consistent with a roost within the impact zone.

Assessing the location of the new PLNb diurnal roost

Triangulating the theoretical flying range from eight of 12 sites (green rays) with calls within 90 minutes of twilight indicates that the roost lies within approximately 3 km of a location 2 km south of Garden Pool (Figure 7). This area is south of the impact area but overlaps with Novo’s tenement. This is primarily an upland area where the Nullagine River and many tributary creeks have cut gorges and gullies into the ranges.

The dispersal pattern of the earliest and latest calls at all sites where PLNb were detected (figure 8) also supports this location as the most likely one for the roost. This pattern shows that all but one of the calls lies within the area that can be reached when flying cross country at or below 20 kph. That one exceptional call in the early morning suggests that the bat was returning to the roost at approximately 25 kph which is well within its commuting capability. Further, this pattern shows that all sites where PLNb were detected, except two, are closer than 20 km to the theoretical roost location. The two exceptions are sites 3N06 and ’14 which are both 23 km distant. Both locations can be reached by bats from Nullagine using river and creekline flyways. The south western site, 3N14, is on a tributary of Bonnie Creek that flows into the Nullagine River. The north eastern site, 3N06, can be reached via Middle Creek, the source of which is a short flight from the Nullagine River at its confluence with Cajuput Creek.

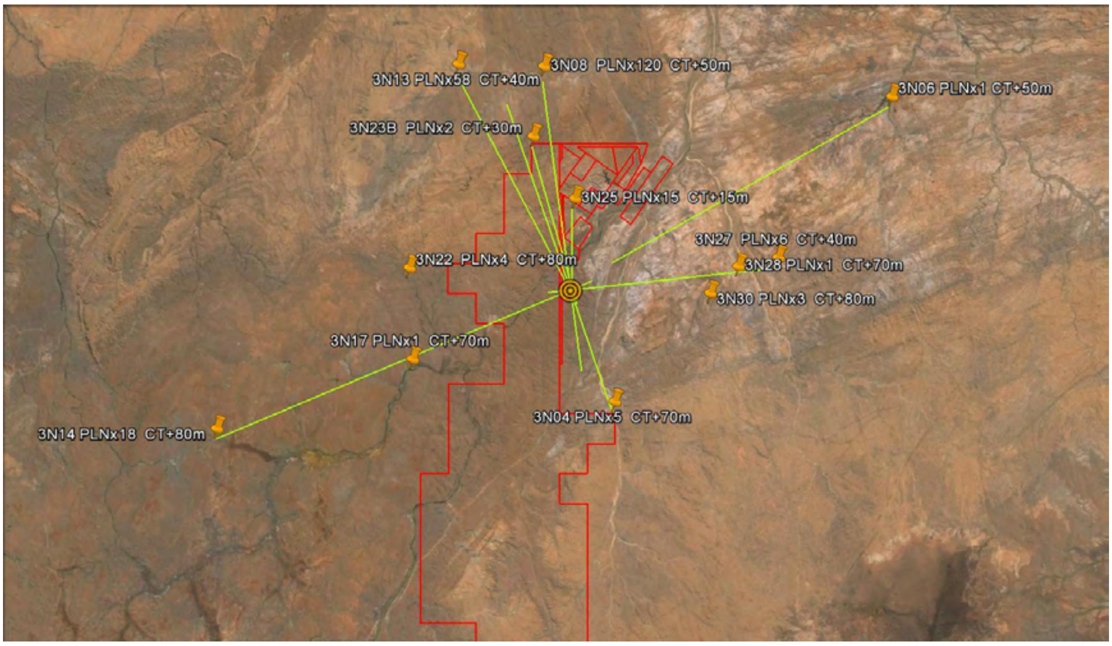


Figure 7. Results at 12 sites with calls within 90 minutes of twilight. Triangulating the theoretical flying range from each (green rays) indicates that the roost lies within approximately 3 km of the location marked with the orange dot to the south of Garden Pool.

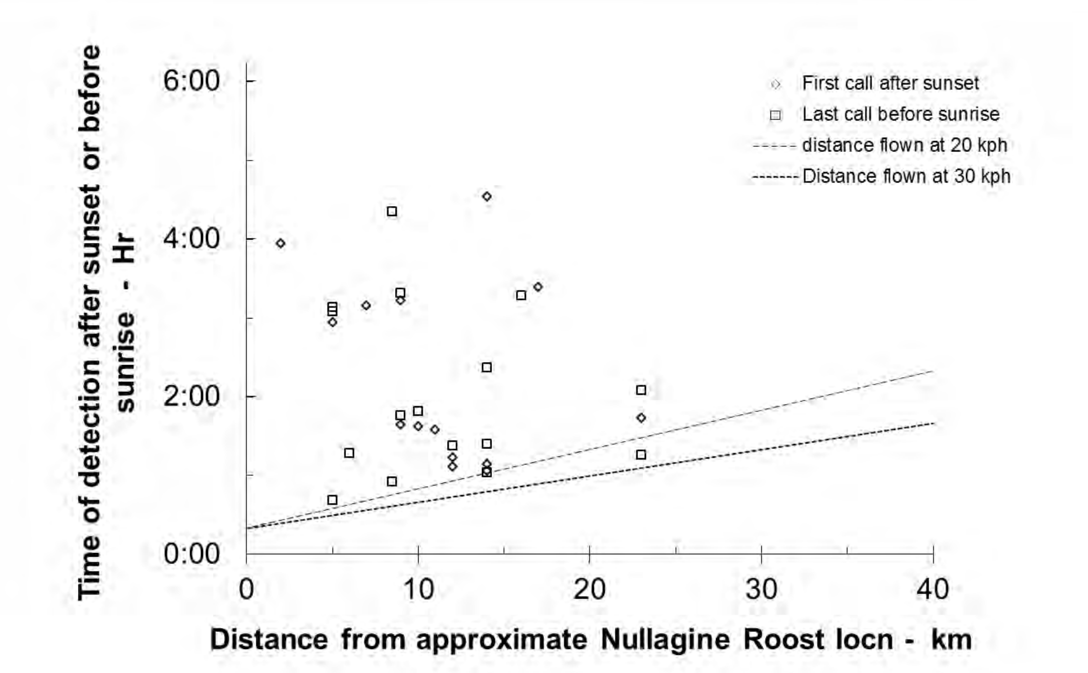


Figure 8. Dispersal pattern of the earliest and latest PLNb calls at all sites where the bat was detected. Note that all except for the last call at site 3N06 fall above the 20 km distance line. That one late call suggests that the bat was returning to the roost at approximately 25 kph which is well within its capability.

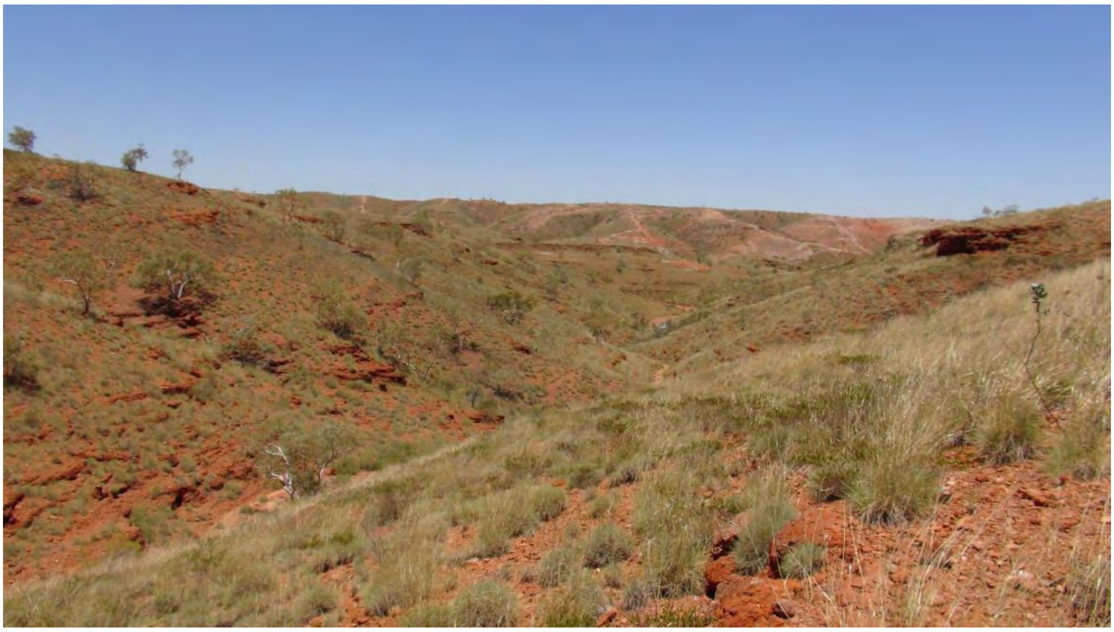
Foraging Habitat Rating Assessment

Habitat ratings were assessed for each of the 40 sites as HR1 through to HR4 (Appendix C). No recordings were made at sites with HR0 (poor) or 5 (close to diurnal roost), (see appendix A). The site habitat ratings are as follows:

- HR1 areas are those that PLNb are unlikely to forage in but may traverse while crossing to more productive areas. The plains to the east of Nullagine are primarily HR1 areas.
- HR2 areas are where PLNb may occasionally forage due to presence of suitable vegetation and seasonal water. They may also use cliff lines and breakaways in these areas as flyways. The valleys in the ranges to the north west of Nullagine are primarily HR2 areas.
- HR3 areas are where PLNb are likely to forage if in range of a roost. They may be detected passing along creek lines, vegetation lines, rock faces or foraging in the most productive areas.
- HR4 areas are where PLNb are very likely to forage and/or drink if in range of a roost.

Images in Figure 9 represent sites typical of each rating.

Figure 9. Images depicting areas with increasing habitat ratings from HR1 (in project area), HR2 (3N20), HR3 (3N06), HR3 (3N29) and HR4 (3N09) within the study area.



Discussion

The ridges and creek lines in the vicinity of the Beatons Creek project have been shown to provide foraging habitat for the PLNb and support medium to high activity levels. These habitats include the Nullagine River and its tributaries of Bonnie, Beatons, Five Mile and Middle Creeks. The majority of the high quality foraging habitat is in the ridges to the south, west and north of the project that contain ephemeral creeks and pools that remain through the dry season and also that contain caves and shelters that are likely to have nightly insect aggregations within their entrances. The area to the east includes two major tributary creeks and a number of historical mine shafts that are preferred foraging locations for the PLNb. It is expected that a significant percentage of the bats from the colony at Nullagine will use these pools, caves and mine entrances on a nightly basis.

Call counts considerably higher than those recorded further south were recorded at two sites on Taylor Creek to the north of the project, 120 and 58 calls at 3N08 and ’13 respectively. As these sites lie approximately 20 km from both Nullagine and the Copper Hills Mine roost, it is possible that PLNb from both roosts forage along this creek. The timing of the closest calls to civil twilight suggests bats originate from Nullagine, while the call numbers suggest that higher numbers of bats are arriving from the Copper Hills Mine later in the evening.

The timing of the earliest and latest calls detected has confirmed that a diurnal roost of PLNb lies within the Nullagine district. The data collected do not prove as yet that this is a maternity roost or that it is occupied for the entire year. Confirmation of these two points along with completing a census of the bats present will follow the discovery of the roost location. The location of this roost is also consistent with the distance to (less than 20 km), and the time increment from daylight for the records from McKenzie and Bullen (2009) and Ninox (2011) (Table 1) where call times are available. For the records from Metcalf and Bamford (2012) and DPaW Nature Map, the distance is also less than 20 km but no timing is available. The possible observation at Bonnie Downs homestead (Metcalf and Bamford (2013)) is also within the wet season range of the PLNb (Bullen 2013). Bonnie Downs homestead is close to the Nullagine River which would have multiple pools present during May and therefore provide a preferred route for commuting.

In conclusion, the systematic methodology applied during this study to collect data to determine the likelihood of the location roost cave(s) within the Beatons Creek project area provides confidence in the finding that the PLNb diurnal roost is outside the proposed footprint of the Project.

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Appendix A. Matrix for assessment of habitat suitability for the Pilbara Leaf-nosed Bat (PLNb)

Habitat Rating (HR) and description	Habitat Type		
	Plains and low hills	**Gullies, ridgelines and mesas**	**Deep Gorges**
Zero (Poor) PLN are unlikely to be detected in these areas	Bare open ground such as salt pans and clay pans without vegetation	Bare mesa and ridge line tops	
1 (Low) PLN are unlikely to forage in these areas but may traverse while crossing to more productive areas	Open plain with one layer of vegetation structure (excluding scattered trees) Two layer, not complex, vegetation structure (excluding scattered trees)	Mesa and ridge line tops. Mesa side or long ridge line with simple geology and minimal caves and overhangs present. Sparse vegetation cover. Shallow non-incised gullies. Spinifex cover to gully floor.	
2 (Moderate) PLN may occasionally forage in these areas due to presence of suitable vegetation, seasonal water and may also use areas as a flyway	Two layer, not complex, vegetation structure (excluding scattered trees). Includes ephemeral watercourse. Open mine shaft entrance	Mesa side or long ridge line with deeply incised gullies in weathered strata (45° sloping walls). Caves and overhangs present. Shrubs in gully base. Ephemeral watercourse in gully or nearby.	
3 (High) PLN are likely to forage in these areas if in range of a roost. They may be detected passing along creek lines, vegetation lines, rock faces or foraging in the most productive areas.	Three layer, complex vegetation structure. Includes ephemeral watercourse Includes mine adit or decline in dry locations.	Mesa side or long ridge line with north facing, deeply incised gullies with vertical walls. Caves and overhangs present. Shrubs and thin tree cover in gully base. Ephemeral watercourse in gully. Includes mine adit in dry locations.	Dry deeply incised gorge into a ridge or mountain Complex three layer vegetation structure. Ephemeral water course.

Habitat Rating (HR) and description	Habitat Type		
	Plains and low hills	**Gullies, ridgelines and mesas**	**Deep Gorges**
4 (Very high) PLN are very likely to forage and/or drink in these areas if in range of a roost and will be detected on a nightly basis.	Includes watercourses and other sites with semi-permanent or permanent surface water (natural or anthropogenic). Three layers in vegetation structure Includes caves entrance or mine adits/declines with water nearby.	Mesa side or long ridge line with south, east or west facing, deeply incised gullies with vertical walls. Caves entrance or mine adit. Vegetation is complex. Semi-permanent or permanent water present Also north facing gullies with permanent water	Wet "open" gorge with hills to the side. Wet "closed" gorge with one or two vertical walls Complex three layer, dense vegetation structure. Semi-permanent or permanent water present
5 (Diurnal roost) PLN are present permanently and will be detected nightly	Areas immediately outside a diurnal roost entrance.	Areas immediately outside a diurnal roost entrance.	Areas immediately outside a diurnal roost entrance.

Appendix B. SM2 Audio settings used during survey.

Parameter	Setting
Sample rate	384,000 kHz
Channel used	Left
Compression protocol	WAC0 (16 bit audio samples)
Gain - left channel	0.00
Digital high pass filter Left channel	fs/4 (giving 96 kHz minimum frequency)
Triggering level Left channel	6SNR (adaptive +6 dB triggering)
Triggering window Left channel	1.0 sec.

Note: These settings are as recommended in Wildlife Acoustics (2010) except the high pass filter. This is set to 96 kHz to target any Pilbara Leaf-nosed Bats that may be present.

Appendix C. Details of sites assessed during the study.

Site	Description	Zone	Easting	Northing	Number of PLNb calls detected	HR
3N01	Ephemeral Pool on tributary creek line	51K	191321	7552333	0	3
3N02	Ephemeral Pool on Nullagine River	50K	809289	7555345	0	3
3N03	Dry bed of Nullagine River amongst complex vegetation	51K	193406	7561917	0	3
3N04	Ephemeral Pool on Cajuput Creek, minimal vegetation.	51K	202368	7563720	5	2
3N05	Dry bed of Five Mile Creek amongst simple vegetation	51K	212950	7567935	0	2
3N06	Bank of ephemeral Middle Creek with complex vegetation	51K	218893	7583629	1	3
3N07	Permanent waterhole on Nullagine River surrounded by complex vegetation	51K	206274	7582980	0	4
3N08	Semi-permanent waterhole on Taylor Creek surrounded by simple vegetation	51K	197333	7585061	120	4
3N09	Large permanent waterhole on Taylor Creek surrounded by simple vegetation	51K	196155	7584959	4	4
3N10	Gully in long rocky cliff line	50K	806105	7582812	6	2
3N11	Overflow pool at Pinnacle Well	50K	801662	7567389	2	3
3N12	Ephemeral creekline (dry) near Pinnacle Well	50K	801779	7567456	0	2
3N13	Semi-permanent pool at unnamed well surrounded by simple vegetation	51K	192018	7585094	58	3
3N14	Unnamed well near Bonnie Creek with simple vegetation	50K	796958	7562855	18	4
3N15	Permanent waterhole on Bonnie Creek surrounded by complex vegetation	50K	807596	7563579	1	4

Site	Description	Zone	Easting	Northing	Number of PLNb calls detected	HR
3N16	Ephemeral Pool at Mooringinya Well, complex vegetation.	50K	805341	7567095	3	3
3N17	Permanent waterhole on Bonnie Creek surrounded by complex vegetation	50K	809175	7566881	1	4
3N18	Bank of lake near Nullagine	51K	201693	7578707	0	4
3N19	Artificially lit tree line within Nullagine township	51K	201738	7576559	0	1
3N20	Rocky breakaway surrounded by simple vegetation	51K	193091	7577078	0	2
3N21	Ephemeral creekline (dry) surrounded by burnt vegetation	51K	190551	7572245	0	2
3N22	Permanent waterhole on unnamed creek surrounded by complex vegetation	50K	809079	7572506	4	4
3N23A	Ephemeral creekline (dry eastern tributary) surrounded by complex vegetation	50K	196821	7580700	1	2
3N23B	Ephemeral creekline (dry western tributary) surrounded by complex vegetation	50K	196737	7580733	2	2
3N24	Permanent waterhole at Garden Pool surrounded by complex vegetation	51K	199427	7573695	2	4
3N25	Permanent waterhole at Beaton Pool surrounded by simple vegetation	51K	199388	7576944	15	3
3N26	Bank of ephemeral Five Mile Creek with complex vegetation	51K	210315	7573583	0	2
3N27	Historical shaft at Five Mile Mining Centre	51K	212055	7573547	6	3
3N28	Historical shaft at Mt Daniel Mine	51K	209595	7572955	1	3
3N29	Historical shaft at Billabong Mine	51K	206021	7572726	5	3

Site	Description	Zone	Easting	Northing	Number of PLNb calls detected	HR
3N30	**Permanent waterhole on unnamed creek surrounded by complex vegetation**	**51K**	**207882**	**7571265**	**3**	**4**
3N31	**Permanent waterhole in Nullagine River surrounded by complex vegetation**	**51K**	**201817**	**7576777**	**3**	**4**
3N32	**Ephemeral creekline (Cajuput Ck, dry) with complex vegetation.**	**51K**	**202434**	**7573220**	**0**	**2**
3N33	**Historical shaft at Victory Line Mine**	**51K**	**202771**	**7574969**	**0**	**3**
3N34	**Historical shaft at Victory Line Mine**	**51K**	**202574**	**7574832**	**0**	**3**
3N35	**Historical adit in project area**	**51K**	**199849**	**7577633**	**0**	**3**
3N36	**Historical adit in project area**	**51K**	**199895**	**7577631**	**0**	**3**
3N37	**Historical adit in project area**	**51K**	**199989**	**7577670**	**0**	**3**
3N38	**Permanent pool in project area surrounded by simple vegetation**	**51K**	**200990**	**7577133**	**4**	**3**
3N39	**Ephemeral creekline (Beaton Ck, dry) with complex vegetation.**	**51K**	**198362**	**7576918**	**0**	**3**

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APPENDIX C

Targeted Northern Quoll Survey

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Beaton's Creek

Targeted Northern Quoll Survey

Prepared for:

Novo Resources

June 2015

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Document Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
830 AC	A INTERNAL DRAFT	LS	RF	1 Electronic (email)	07/07/15
830 AC	B CLIENT REPORT	LS	FJ & RF	1 Electronic (email)	03/07/15

Executive Summary

360 Environmental Pty Ltd was commissioned by Novo Resources Corp in December 2014 to undertake a targeted Northern Quoll (Quoll - *Dasyurus hallucatus*) survey at Beaton's Creek. Novo are proposing to develop a gold mine in the Survey Area. The Survey Area is approximately 1,172 ha, adjacent to Nullagine in the Pilbara, and approximately 1,200 km north east of Perth, Western Australia.

The background to the survey was the recording of one Quoll on a motion sensitive camera in the Survey Area during the level 2 baseline vertebrate fauna survey undertaken in October 2014 by 360 Environmental. Prior to that, a Quoll scat was collected during the level 2 flora and vegetation assessment of the same Beaton's Creek Survey Area in September 2014.

At the time of the survey, the Quoll was listed as endangered under both the Western Australia *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Northern Quoll was returned in records from the EPBC Protected Matters Database Search, the Department of Parks and Wildlife threatened database search and the state-wide NatureMap.

The field survey was undertaken for a total of six nights from 8 – 14 April 2015. The trapping programme methods followed as closely as possible and where practical, the methodology outlined in the DPaW Pilbara Regional Quoll Project survey and monitoring document (Dunlop *et. al.* 2014).

In the Pilbara, Quolls often live and shelter in rocky linear habitats, as such trapping transects instead of trapping grids are used, as they are likely to give better capture/detection results.

Two transects (four sub-transects), consisting of cage traps and motion sensitive cameras, were set up in the Survey Area. Transect 1 (lower and upper) was set up in the general area where the previous Quoll was recorded on the motion camera. Transect 2 (lower and upper) was set up in the north western section of the Survey Area at a location considered to have the best developed minor gorge in the Survey Area.

Total cage trap effort for the survey was 411 trap nights. No Quolls were captured in cage traps during the survey. The only animals captured in the cage traps during the survey were three Common Rock-rats (*Zyzomys argurus*). Motion camera effort for the survey was 26 camera nights. No Quolls were recorded on the motion cameras during the survey. A total of 20 person hours was spent searching for scats along transects and in other parts of the Survey Area that contained habitat often associated with the presence of Quolls, such as drainage lines/ minor gorges and gullies and in disused adits. No scats were observed.

Habitat in the Survey Area for Quolls would be at best described as low quality as there are few well developed gullies or gorges with large crevices and boulders for them to shelter and den in and under. There are also no rock or boulder piles that are substantial enough for them to shelter and den in. Further to this there are no substantial watercourses in the Survey Area with large enough trees that would have hollows suitable for denning. The one Quoll that was recorded on the motion camera in October 2014 was most likely denning in the adit adjacent to where it was recorded, particularly as there was a fig tree outside the adit. Quolls are known to consume the fleshy fruits of figs and other plants.

Given the limited and sub optimal habitat in the Survey Area and the recording of only one scat in September 2014 and one Quoll on a motion camera in October 2014, no records during this survey, there is unlikely to be a substantial population in the Survey Area. It is important to note that many fauna (including Quolls) are not distributed evenly across the landscape, are more abundant in some places than others, and consequently more detectable and this detectability can vary in space and time. In 2013, surveys were undertaken by DPaW in the Nullagine region as part of the Pilbara Northern Quoll Regional Project. The nearest evidence of Quolls (scats) comes from about 30 km west of Nullagine (Judy Dunlop pers. comm.). Quolls may only use the Survey Area intermittently when there are resources available such as figs.

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1 Introduction and Background Information

1.1 The Project

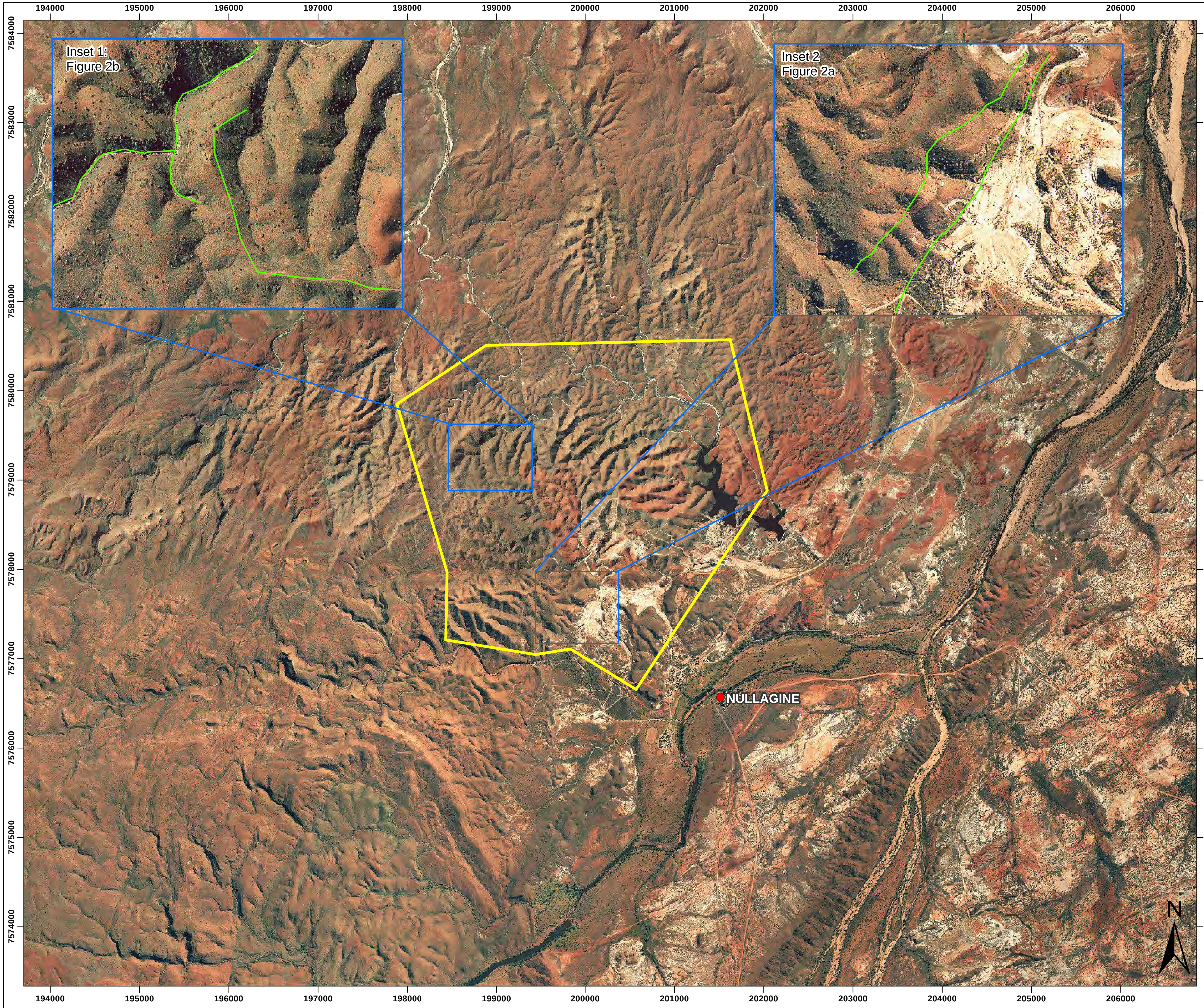
360 Environmental Pty Ltd (360 Environmental) was commissioned by Novo Resources Corp (Novo) in December 2014 to undertake a targeted Northern Quoll (Quoll) survey at Beaton's Creek (the Survey Area). Novo are proposing to develop a gold mine in the Survey Area. The Survey Area is approximately 1,172 ha, adjacent to Nullagine in the Pilbara, and approximately 1,200 km north east of Perth, Western Australia (WA) (Figure 1). The Survey Area is greater in extent than the proposed mine footprint.

The reason for the survey was the recording of one Quoll on a motion sensitive camera (same location as the scat mentioned below in the next sentence) in the Survey Area during the level 2 baseline vertebrate fauna survey undertaken in October 2014 by 360 Environmental (360 Environmental 2015). Prior to this a Quoll scat was collected during the level 2 flora and vegetation assessment of the same Beaton's Creek Survey Area in September 2014 (MMWC Environmental 2015).

The Quoll is listed as endangered under both the Western Australia (WA) *Wildlife Conservation Act 1950* (WC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In November 2014, staff from 360 Environmental and Novo Resources met with staff from the WA Department of Parks and Wildlife (DPaW) that are involved in the Pilbara Quoll project to discuss the recording of the Quoll, including a survey approach to be undertaken to more fully understand the distribution of Quolls in the area. The survey methods described in this document are based on the discussions of that meeting and the survey methods outlined in the relevant Quoll DPaW document for the Pilbara (Dunlop *et al*. 2014).

The primary objective of the survey was to get a better understanding of the distribution and relative abundance of the Quoll across the Survey Area.



Legend

Survey Area

Transects

- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

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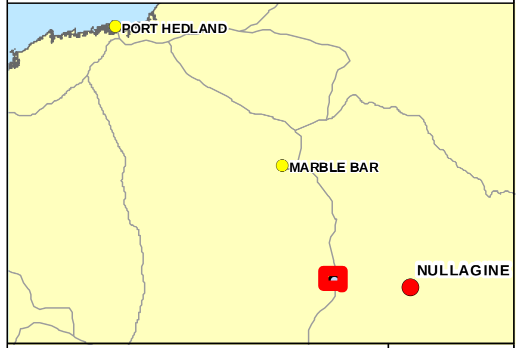

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Novo Resources
Beatons Creek, Nullagine

Northern Quoll Survey

Figure 1 Site Location

K:\Projects\1.0 EBS\684 Beatons Creek Fauna\Figures

1.2 Background to the Protection of Fauna

Fauna is protected formally and informally by various legislative and non-legislative measures, which are as follows:

- Legislative measures:
  - EPBC Act;
  - WC Act; and
  - *Environmental Protection Act 1986* (EP Act);
- Non-legislative measures:
  - WA Department of Parks and Wildlife (DPaW) Priority lists fauna; and
  - Recognition of locally significant populations by the DPaW.

A short description of each is given below. Other definitions, including species conservation categories, are provided in Appendix A.

1.2.1 EPBC Act

The EPBC Act aims to protect matters of national environmental significance (MNES). Under the EPBC Act, the Commonwealth Department of the Environment (DotE) lists threatened species and communities in categories determined by criteria set out in the Act (www.environment.gov.au/epbc/index.html) (Appendix A).

Projects likely to cause a significant impact on MNES should be referred to the Department of the Environment for assessment under the EPBC Act.

1.2.2 WC Act

The WA DPaW lists fauna under the provisions of the WC Act as protected according to their need for protection (Appendix A). Fauna are classified as Schedule 1 to Schedule 4 according to their need for protection.

1.2.3 EP Act

Significant habitat necessary for the maintenance of fauna indigenous to WA as well as Threatened Ecological Communities (TECs) are given special consideration in environmental impact assessment, and areas covered by TECs have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*

1.2.4 DPaW Priority Lists

The DPaW lists 'Priority' fauna that have not been assigned statutory protection as 'Scheduled' under the WC Act, but which are under consideration for declaration as 'Scheduled' fauna. Fauna assessed as Priority 1-3 are considered to be in urgent need of further survey. Priority 4 fauna require monitoring every 5-10 years and Priority 5 fauna are subject to a specific conservation program (Appendix A).

1.3 Relevant Northern Quoll Guidance Documents for the Pilbara

At the time of writing, there were two guidance type documents that are of some relevance to surveys and projects involving the Quoll in the Pilbara, and these will be briefly discussed below in terms of how they relate to this survey.

1.3.1 EPBC Act Referral Guidelines for the Endangered Northern Quoll (EPBC Act policy statement 3.25)

The EPBC Act referral guidelines document for the endangered Quoll provides guidance and advice on whether or not, for example, a targeted survey should be undertaken and when it should be carried out. The referral guidelines state the following with regard to a targeted survey:

- A targeted survey is recommended for any proposal occurring within the modelled distribution of the species where the reconnaissance survey identifies the presence of the Quoll and / or habitat critical to the survival of the Quoll.

The referral guidelines also provide advice on risk of impacts and whether or not a referral is required for a project that is for example likely to impact Quoll habitat, or which may create barriers or restrict the movement between populations of the Quoll.

1.3.2 Pilbara Northern Quoll Regional Project –Surveying and monitoring *Dasyurus Hallucatus* in the Pilbara, Western Australia

The main objectives of the Pilbara Quoll Regional Project being undertaken by DPaW are to determine the distribution, abundance and to improve the ecological knowledge of the Quoll in the Pilbara. The accompanying document provides methods to be used to achieve these objectives and more importantly it provides other organisations undertaking Quoll projects with methods so that they can contribute comparable data in to the regional Quoll project.

1.4 Summary of Northern Quoll Ecology

1.4.1 Description

The Quoll is a distinctive carnivorous marsupial, about the size of a small cat (adult weight range approximately 300 -1,100 g) and is the smallest of the Quoll species. It has prominent white spots on a generally dark body, with a long sparsely furred tail (Van Dyck & Strahan 2008).

1.4.2 Distribution

The range of the Quoll has contracted across northern Australia since European settlement, but its decline has accelerated since the arrival of the cane toad, and it now occurs as several disjunct populations (Braithwaite & Griffiths 1994; Van Dyck & Strahan 2008). Extant populations of the Quoll include near coastal upland areas of eastern Queensland (QLD), in the Northern Territory (NT) few mainland populations are known to remain, but small numbers still persist in Kakadu National Park (KNP). However, in the NT populations now primarily occur on several islands, including island strongholds such as Groote Eylandt (Woinarski *et al.* 2012).

In WA the Quoll is still widespread particularly in the North Kimberley in rocky areas, for example, Mitchell River National Park and surrounding areas, Price Regent coastal and inland areas, the Artesian Range and Yampi Peninsula and there are a few populations in the central Kimberley (e.g. Mornington Stations [Australian Wildlife Conservancy]). The Quoll also occurs on many islands in the Kimberley (Woinarski *et al.* 2012). In the Pilbara the Quoll is still relatively widespread, particularly in rocky areas and it still occurs on one island – Dolphin Island (How *et al.* 2009; Woinarski *et al.* 2012).

1.4.3 Ecology

The Quoll is found in dissected rocky escarpments, utilising a variety of den sites, including rock crevices, tree hollows, logs and termite mounds. It favours rocky areas, taking refuge in rock crevices, and utilises gullies and drainage lines.

It is important to note that much of the ecological information for the Quoll comes from studies in the Top End of the NT (e.g. Begg 1981; Oakwood 2002). Much of their ecology is likely to be similar in the Pilbara; however, differences in genetic structure and some demographic parameters have been observed (How *et al.* 2009).

The Quoll has a relatively large home-range size of up to 150 ha for males (35 ha for females). Movements between den sites on consecutive nights can be up to 1.85 km for males (Oakwood 2002). In the NT, mating occurs in late May to June. All males die after the mating season and the female's rear the young alone (Oakwood 2000). The young spend about two months in the pouch and are then left in a succession of nursery dens for the next three months, for periods at night while the mother forages (Oakwood 2000). In the Kimberley, Schmitt *et al.* (1989) found that breeding occurred in July and August. However, at Woodstock Station in the Pilbara, breeding occurred in September, a month later than the Kimberley (How *et al.* 2009). This variation in time of breeding across three distinct populations indicates some reproductive flexibility in the species.

2 Desktop Assessment

2.1 Fauna Database Review

Searches of the EPBC Protected Matters Search Tool (PMST) and DPaW's threatened fauna database (both 50 km radial search) had been undertaken at the end of August 2014 for the baseline vertebrate fauna survey (DotE 2014a; DPaW 2014a; 360 Environmental 2015). Given that these database searches had only been done seven months prior to this survey, they were considered recent enough in order to see if there were any records of the Northern Quoll in and surrounding the Survey Area.

A NatureMap state-wide search was undertaken for the period 01/01/2000 – 07/06/2015 to examine the number of Quoll records for that period, with a particular focus on the Pilbara for context (DPaW 2014b).

2.2 Previous Biological Studies

In recent decades, an increase in resource development projects has resulted in a significant amount of site-specific (i.e. local scale) biological survey work being carried out, most of which is undertaken for approvals under the EP Act.

A major systematic field survey of biodiversity by the Department of Environment and Conservation (DEC) (now known as DPaW) in the Pilbara was conducted during 2002-2007 (McKenzie *et al*. 2009). These biodiversity surveys included (among other fauna groups) systematic sampling of small mammals, micro bats and birds (Gibson & McKenzie 2009, McKenzie & Bullen 2009, Burbidge *et al*. 2010).

Some examples of recent past consultant fauna surveys undertaken in the vicinity of the Survey Area can be seen in Table 1, including surveys carried out in the Nullagine region in 2013 as part of the Pilbara Regional Quoll Project. These recent examples include a level 2 fauna survey (360 Environmental 2014); a level 1 and targeted conservation significant survey (Bamford Consulting Ecologists 2013b), a level 2 and targeted fauna survey (ENV. Australia 2012; ENV. Australia 2011) and a fauna assessment (Bamford Consulting Ecologists 2009). Only three of the past surveys have recorded the Quoll (Table 1).

Table 1: Summary of recent fauna surveys undertaken near the Survey Area

Survey	Survey Type	Survey Date	Methods	Key Findings: Significant Species
360 Environmental (2014). Baseline Vertebrate Fauna Survey, Beaton's Creek	Level 2 fauna survey	October 2014	o Trapping grids, pitfall, cage, Elliott and funnel trapping; active searches, spotlighting; bird survey; bat survey (SM2); opportunistic observation o Searches for evidence of conservation significant fauna o Motion sensitive cameras	o Black-lined Ctenotus (*Ctenotus nigrilineatus*) o Rainbow Bee-eater (*Merops ornatus)* o Western Pebble-mouse (*Pseudomys chapmani*) o Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia)* o **Quoll recorded on motion camera**
DPaW Pilbara Northern Quoll Regional Project – surveys in the Nullagine region	Targeted Survey	2013	o Motion sensitive cameras	o The nearest evidence of Quolls (scats) comes from about 30 km west of Nullagine (Judy Dunlop pers. comm.)
Bamford Consulting Ecologists (2013). BC Iron Nullagine Project Extension Areas – Bonnie East, Warrigal North and Coongan Assessment of Fauna	Level 1 and targeted conservation species assessments and review of previous	May 2012	o Opportunistic observations of fauna (particularly birds); and o Searches for evidence of conservation significant fauna	o Grey Falcon (*Falco hypoleucos*) o **Quolls scats recorded in 2011**

SURVEY	SURVEY TYPE	SURVEY DATE	METHODS	KEY FINDINGS: SIGNIFICANT SPECIES
Values	surveys in the area			
ENV. Australia (2012). Christmas Creek Terrestrial Vertebrate Fauna and Fauna Habitat Assessment	Level 2 survey	March 2011	o Trapping grids, pitfall, cage, Elliott and funnel trapping; active searches, spotlighting; bird survey; bat survey (SM2)	o Pilbara Olive Python (*Liasis olivaceus barroni*) o Rainbow Bee-eater (*Merops ornatus)* o Australian Bustard (*Ardeotis australis)* o Western Star Finch (*Neochmia ruficauda subclarescens*) o No Quolls recorded
ENV. Australia (2011). Targeted threatened species surveys at Christmas Creek	Level 2 targeted survey	July 2011	o Transects of Cage and Elliott traps and motion cameras	o No Quolls recorded
Ninox Wildlife Consulting (2011). A Vertebrate Fauna Survey of Proposed Satellite Mining Areas, near Nullagine, WA	Level 2 survey	Autumn and Spring 2010	o Trap lines, pitfall, cage, Elliott and funnel trapping; active searches, bird survey, bat survey (AnaBat)	o Australian Bustard (*Ardeotis australis*) o Rainbow Bee-eater (*Merops ornatus*) o Brush-tailed Mulgara (*Dasycercus blythi* o Bilby (*Macrotis lagotis*) o Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia)* o Black-lined Ctenotus (*Ctenotus*

SURVEY	SURVEY TYPE	SURVEY DATE	METHODS	KEY FINDINGS: SIGNIFICANT SPECIES
				nigrilineatus) ○ No Quolls recorded
Bamford Consulting Ecologists (2009). Fauna Assessment of the BC Iron Nullagine Direct Shipping Ore Project	Unknown	2008	○ Unknown	○ Quoll captured and scats recorded

3 Quoll Survey Methods

3.1 Trapping Programme

The field survey was undertaken for a total of six nights from 8 – 14 April 2015. The trapping programme methods followed as closely as possible and where practical, the methodology outlined in the DPaW Pilbara Regional Quoll Project survey and monitoring document (Dunlop *et. al.* 2014).

In the Pilbara, Quolls often live and shelter in rocky linear habitats, as such trapping transects instead of trapping grids are often used, as they are likely to give better capture/detection results.

Two transects (Figures 2a and b) were set up in the Survey Area, with each transect consisting of two sub-transects (named lower and upper).

Transect 1 (both lower and upper) was set up in the general area where the previous Quoll was recorded on the motion camera (Figure 2a). Both sub-transects were set up perpendicular to the slope. In addition, one motion camera and three cage traps were also set up for five nights where the previous Quoll and scat was recorded (Figure 2a).

Transect 2 was set up in the north western section of the Survey Area (Figure 2b). This location was chosen as it was considered the best developed minor gorge in the Survey Area. Transect 2 (lower) was placed down in this minor gorge, while transect 2 (upper) was placed up on top of a ridge that had a vehicle track running along it (this transect consisted of cage traps that were for the most part paired either side of the track) (Figure 2b).

The configuration of each sub-transects and methods used were as follows:

- Each sub transect consisted of 25 wire cage traps (45 x 17 x 17 cm) (four sub transects and 100 cage traps in total across two transects);
- Cage traps were baited with peanut butter, oats and sardines (with some water added);
- Each cage trap was spaced approximately 50 m apart (except transect 2 upper where traps were mostly paired [opposite sides of a track and about 10 m apart], with each pair of traps about 50 m apart);
- Each cage trap was covered with a hessian sack and placed in the shade where possible;
- Traps were open for four consecutive nights, checked within three hours of sunrise and closed, then reopened and rebaited in the afternoon; and

- Each cage trap location had pink flagging tape next to it and the co-ordinates were recorded with a GPS (Appendix B).

Each transects was approximately the following length:

- Transect 1 Lower – 920 m;
- Transect 1 Upper – 900 m;
- Transect 2 Lower – 850 m; and
- Transect 2 Upper – 770 m.

Some examples of each transect can be seen below in plates one through to six.

Plate 1: Transect 1 Lower (near cage trap 3).

Plate 2: Transect 1 Upper (near cage trap 23).


Plate 3 & 4: Transect 2 Lower (near cage trap 14 and general view of the minor gorge).

Plate 5: Transect 2- Upper (near cage traps 3a & b).

Plate 6: Transect 2 Lower (cage trap logistics [lowering cage traps into the minor gorge]).

Legend

- Survey Area
- Transects
- Cage Locations
- Camera Trap Locations
- Previously Northern Quoll Location

- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

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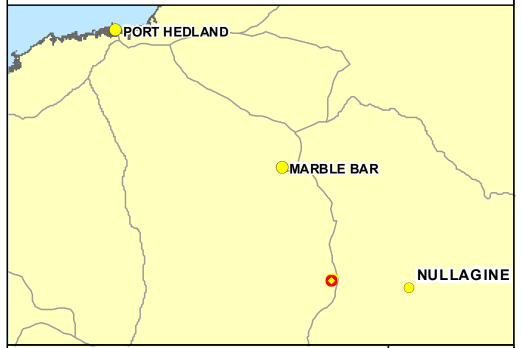
LOCALITY MAP



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Novo Resources
Beatons Creek, Nullagine

Northern Quoll Survey

Figure 2a Survey Transects

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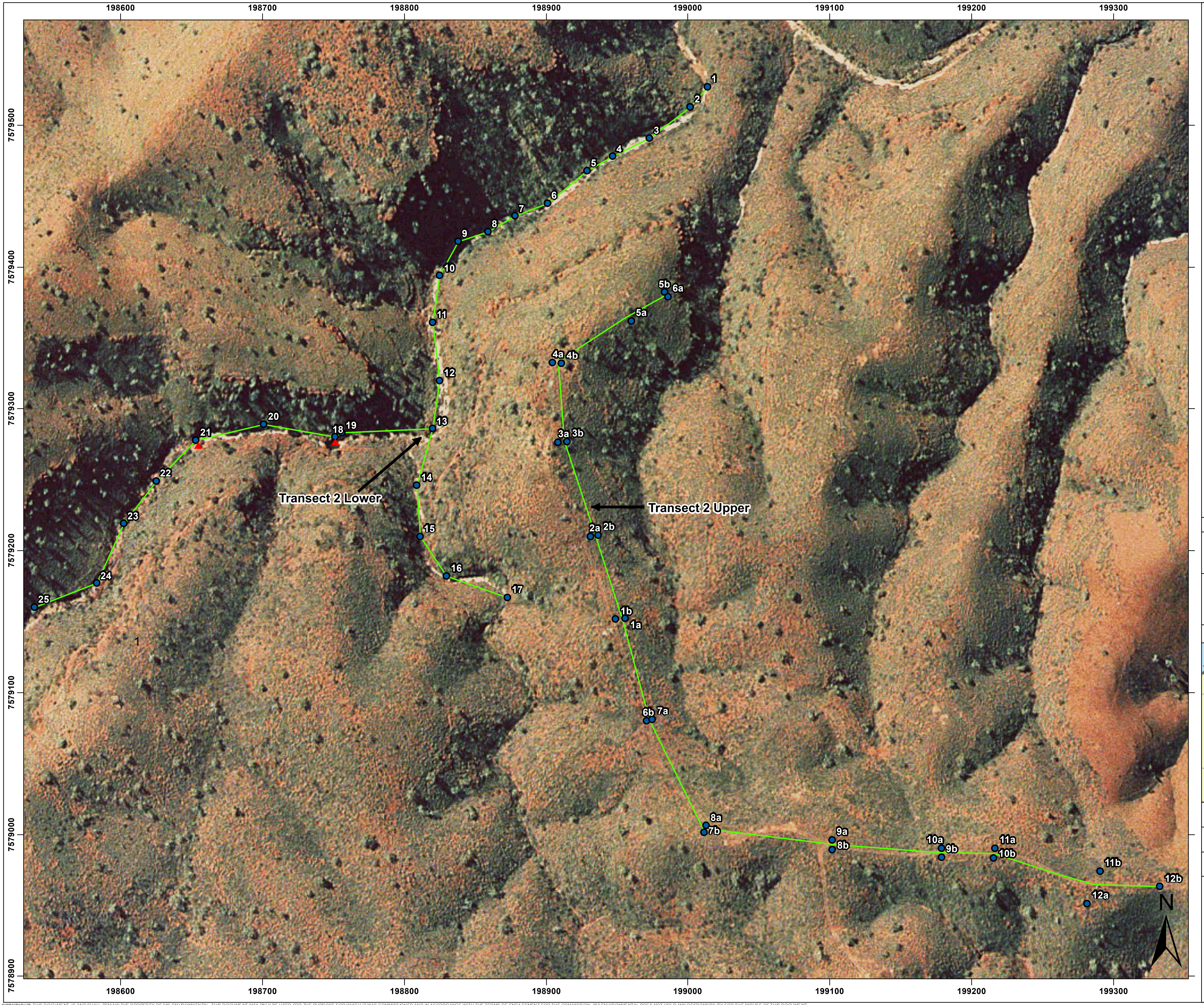

Legend

- Survey Area
- Camera Trap Locations
- Cage Locations
- Transects

- 360 ENVIIRONMENTAL RECORDED FIELD DATA
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007 NULLAGINE (© Western Australian Land Information Authority 2014)

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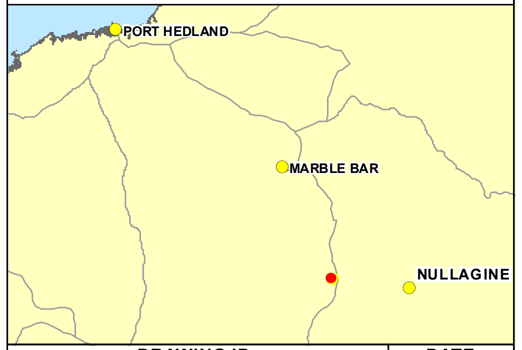
LOCALITY MAP



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TD	LS	RF	0

Novo Resources
Beatons Creek, Nullagine

Northern Quoll Survey

Figure 2b Survey Transects

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3.2 Motion Sensitive Cameras

Eight motion sensitive cameras were setup during the field survey at eight separate locations (Appendix C and Figures 2a and b). The motion cameras were setup along the trapping transects and as mentioned in section 3.1, one was also set up where the previous Quoll was recorded. Apart from motion cameras that were positioned in front of traps, each motion camera was baited with universal bait and re-baited daily.

3.3 Scat Searches

Searches for scats were undertaken in some sections of the Survey Area, especially in gullies, drainage lines and minor gorges where Quolls might den (this included some of the old adits in the Survey Area). Scat searches were also undertaken along the trapping transects.

3.4 Habitat Assessment

Habitat assessments were undertaken at each of the four sub-transects and where the Quoll (and scat) was recorded previously on a motion camera. The proformas provided in the Pilbara Northern Quoll regional project document were used (Dunlop *et al.* 2014). This habitat sheet was used to ensure standard data was collected in a consistent way to enable comparison with other recent and future work in the area, thereby providing a consistent contribution to regional knowledge of the Quoll (Appendix D). A habitat assessment was also undertaken where the previous Quoll was captured on the motion sensitive camera (Appendix D).

4 Results

4.1 Fauna Survey Limitations and Constraints

Survey constraints are often difficult to predict, as is the extent to which they influence survey effort. Survey limitations and constraints of the fauna survey are outlined below in Table 3.

Table 2: Limitations and constraints associated with the survey

VARIABLE	IMPACT ON SURVEY OUTCOMES
Access	Access for the most part was only limited to a few relatively small sections of the Survey Area, due to the limited number of tracks. All locations that were thought to be suitable Quoll habitat were accessible.
Experience	The personnel who executed these surveys were practitioners suitably qualified in their respective fields: • Coordinating Zoologist: Dr Ron Firth has 15 years of survey experience, including undertaking surveys for the Northern Quoll in the Northern Territory and WA; and • Field Staff and Reporting: Laura Stevens (Zoologist); and • Report Review: Dr Ron Firth.
Timing	Northern Quolls are active all year round, however, surveys are recommended between April and September to avoid times when females have large or denned pouch young.
Sources of information	Relevant DPaW and EPBC database searches were undertaken for the Survey Area and are listed in section 2.1 and some other survey reports for the general area were reviewed and are listed in Table 1 (see section 2.2).
Completeness	The time spent conducting the survey was considered adequate for the size and complexity of the site and the level of proposed disturbance.
Disturbances	Some sections of the Survey Area are disturbed as a result of historic mining and from recent exploration activities. However, this is unlikely to impact this survey as Quolls are known to use disturbed areas or places of human habitation. And the Quoll recorded on a motion camera during the level 2 baseline survey was adjacent to an old adit.

4.2 Database Review

The Quoll did come up in the EPBC database search as being likely to occur or its habitat likely to occur (Appendix E). The DPaW threatened database search provided 12 records of the Northern Quoll within the 50 km radial search area. Of these records, one is from 1899 (and is a museum specimen); another is from 1979 with its locality recorded as Nullagine (Appendix F). The other 10 records are from between 2011 and 2012 and are either from the Blue Spec Gold Mine (approximately 20 km north east of Nullagine) or Atlas Irons McPhee Creek (about 30 km north of Nullagine) (Appendix F). The NatureMap state-wide search for the period 01/01/2000 – 07/06/2015 provided numerous records of the Quoll across the wider Pilbara area (Figure 3).

4.3 Trapping Programme

Total cage trap effort for the survey was 411 trap nights, which included 396 trap nights for the trapping transects and 15 trap nights for the cages placed at the adit where the Quoll (and scat) was previously recorded on a motion camera. No Quolls were captured in cage traps during the survey. The only animals captured in the cage traps during the survey were three Common Rock-rats (*Zyzomys argurus*).

4.4 Motion Sensitive Cameras

Total cage trap effort for the survey was 411 trap nights, which included 396 trap nights for the trapping transects and 15 trap nights for the cages placed at the adit where the Quoll (and scat) was previously recorded on a motion camera. No Quolls were captured in cage traps during the survey. The only animals captured in the cage traps during the survey were three Common Rock-rats (*Zyzomys argurus*).

4.5 Scat Searches

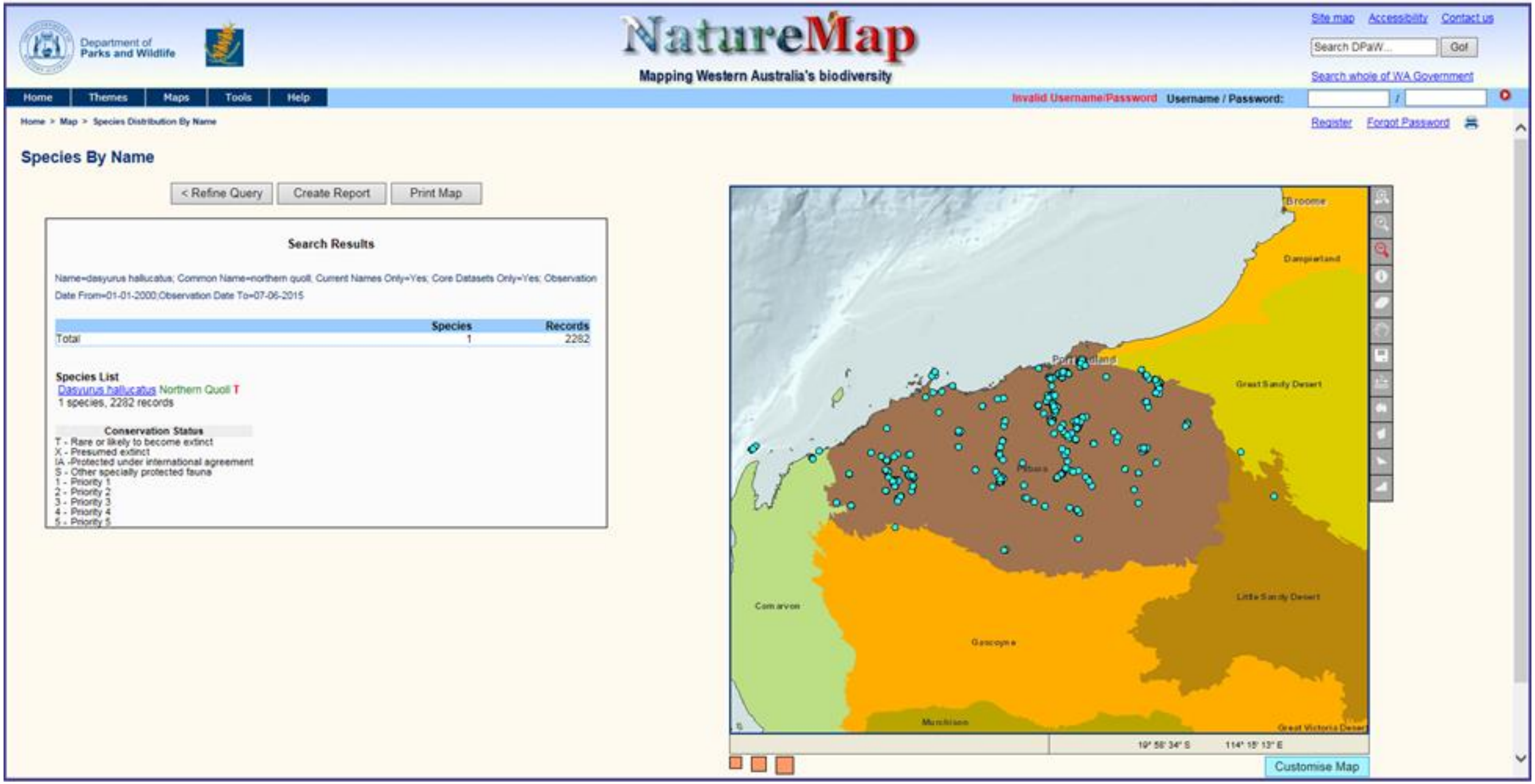
A total of 20 person hours was spent searching for scats along transects and in other suitable areas of the Survey Area, such as drainage lines/ minor gorges and gullies and in disused adits. No Quoll scats were observed.

4.6 Habitat Assessment

The habitats of the Survey Area are considered to be in variable condition from highly disturbed as a result of historic mining and current exploration activity (transect 1 lower) to no effective disturbance (transect 2 lower)(Appendix D).

The sub transects of Transect 1 lower ran parallel along the lower slope of the hills and was highly disturbed, primarily as a result of historic mining activity (see Plate 1 – section 3.1 above). Transect 1 upper was placed primarily on the upper slopes of the low hills (though it did cross gullies and small drainage lines and ended in a drainage line) (see Plate 2 – section 3.1 above). Transect 2 lower ran in the bottom of a minor gorge (see

Plates 3 and 4), while transect 2 upper ran along a ridge (see Plate 5 – section 3.1) (Appendix D).


Site map
Accessibility
Contact us
Department of Parks and Wildlife
NatureMap
Mapping Western Australia's biodiversity
Search DPaW...
Go!
Search whole of WA Government
Home
Themes
Maps
Tools
Help
Invalid Username/Password
Username / Password:
Home > Map > Species Distribution By Name
Register
Forgot Password
Species By Name
< Refine Query
Create Report
Print Map
Search Results
Name=dasyurus hallucatus; Common Name=northern quoll; Current Names Only=Yes; Core Datasets Only=Yes; Observation Date From=01-01-2000;Observation Date To=07-06-2015
Species
Records
Total
1
2282
Species List
Dasyurus hallucatus Northern Quoll T
1 species, 2282 records
Conservation Status
T - Rare or likely to become extinct
X - Presumed extinct
IA -Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5
Broome
Dampierland
Port Hedland
Great Sandy Desert
Pilbara
Carnarvon
Gascoyne
Little Sandy Desert
Murchison
Great Victoria Desert
19° 58' 34" S
114° 15' 13" E
Customise Map

5 Discussion

5.1 Distribution in the Project Area

No Quolls were recorded during the survey despite 411 cage trap nights and 26 motion camera nights of effort. In October 2014 one Quoll was recorded on a motion camera that was positioned at the entrance to an adit, in front of this entrance was a fig tree (*Ficus brachyopoda*) that had fruit on it. And one month prior to this, a Quoll scat was recorded in the same location. The last Quoll record for Nullagine comes from 1979 and anecdotes from local residents indicate that they haven't seen Quolls in the town for around 30 years. In the local region, the nearest and most recent Quoll records come from the Blue Spec Mine (2011), McPhee Creek Mine (2012) and from BC Iron's Nullagine Project in 2008 which is about 25 km south west of Nullagine (Table 1).

Habitat in the Survey Area for Quolls would be at best described as low quality as there are few well developed gullies or gorges with large crevices and boulders for them to shelter and den in and under. There are also no rock or boulder piles that are substantial enough for them to shelter and den in. Further to this there are no substantial watercourses in the Survey Area with large enough trees that would have hollows suitable for denning. The one Quoll that was recorded on the motion camera in October 2014 was most likely denning in the adit adjacent to where it was recorded, particularly as there was a fig tree outside the adit. Quolls are known to consume the fleshy fruits of figs and other plants (Oakwood 1997; Van Dyck & Strahan 2008).

Given the limited and sub optimal habitat in the Survey Area and the recording of only one Quoll on a motion camera in 2014 and no records during this survey, there is unlikely to be a substantial population in the Survey Area. In fact Quolls may only use the Survey Area intermittently when there are resources available such as figs. Nevertheless, it is important to note that many fauna (including Northern Quolls) are not distributed evenly across the landscape and are more abundant in some places than others. They are consequently more detectable and this detectability can vary in space and time (Currie 2007).

In 2013, surveys were undertaken by DPaW in the Nullagine region as part of the Pilbara Northern Quoll Regional Project. The nearest evidence of Quolls (scats) comes from about 30 km west of Nullagine (Judy Dunlop pers. comm.).

5.2 Potential Impacts to the Northern Quoll

The EPBC Act referral guidelines for the endangered Northern Quoll (DSEWPaC 2011) provide general guidance on what, in the department's view, may be at high and low risk of requiring a referral to the department, as well as providing some guidance on uncertainty. These guidelines have been considered with respect to potential impacts to the Quoll as a result of proposed activities associated with mining in the Survey Area.

If Quolls do permanently occur in the Survey Area and in the general Nullagine area, their densities are likely to be very low, consequently activity associated with mining in the Survey Area such as habitat removal and the resulting potential impacts to Quolls are likely to be very minimal. In a broader context potential impacts at the regional scale (including the Pilbara) to Quoll populations are highly unlikely to be significant based on the outcome of this survey and recent local survey effort.

6 Acknowledgements

360 Environmental would like to thank Judy Dunlop and Julia Lees from DPaW for arranging access to and for the use of 80 cage traps from the DPaW Woodvale office.

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APPENDIX A

Definition of Threatened Fauna Species Categories

Western Australian Threatened Fauna Categories Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

Department of Parks and Wildlife Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Categories of Threatened Fauna Species under the EPBC Act

Conservation Code	Description
Ex	**Extinct** Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.

E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Source: *Environment Protection and Biodiversity Conservation Act 1999*

APPENDIX B

Cage Trap Coordinates for each Transect

Linear Transect No.	Cage No.	Easting*	Northing*	Linear Transect No.	Cage No.	Easting*	Northing *
Transect 1 - Lower	1	0199741	7577185	Transect 1 - Upper	1	0199599	7577291
	2	0199752	7577217		2	0199613	7577309
	3	0199768	7577247		3	0199634	7577339
	4	0199793	7577295		4	0199666	7577357
	5	0199983	7777344		5	0199686	7577389
	6	0199849	7577383		6	0199709	7577412
	7	0199871	7577410		7	0199735	7577441
	8	0199899	7577431		8	0199756	7577460
	9	0199923	7577458		9	0199771	7577491
	10	0199943	7577489		10	0199801	7577532
	11	0199974	7577528		11	0199826	7577459
	12	0199994	7577553		12	0199828	7577581
	13	0200010	7577606		13	0199832	7577613
	14	0200027	7577638		14	0199833	7577662
	15	0200043	7577665		15	0199864	7577702
	16	0200061	7577695		16	0199894	7577720
	17	0200076	7577718		17	0199933	7577739
	18	0200099	7577757		18	0199966	7577763
	19	0200130	7577799		19	0199994	7577785
	20	0200140	7577829		20	0200012	7577808
	21	0200151	7577862		21	0200057	7577830
	22	0200163	7577887		22	0200072	7577862
	23	0200178	7577919		23	0200091	7577895
	24	0200204	7577962		24	0200135	7577960
					25	0200135	7577960

Linear Transect No.	Cage No.	Easting*	Northing*	Linear Transect No.	Cage No.	Easting*	Northing *
Transect 2 - Upper	1a	0198956	7579152	Transect 2 - Lower	1	0199014	7579527
	1b	0198956	7579152		2	0199002	7579513
	2a	0198937	7579211		3	0198973	7579491
	2b	0198937	7579211		4	0198947	7579478
	3a	0198915	7579277		5	0198929	7579468
	3b	0198915	7579277		6	0198901	7579445
	4a	0198911	7579332		7	0198878	7579436
	4b	0198911	7579332		8	0198859	7579425
	5a	0198957	7579363		9	0198838	7579418
	6a	0198986	7579379		10	0198825	7579394
	6b	0198986	7579379		11	0198820	7579361
	7a	0198975	7579081		12	0198825	7579320
	7b	0198975	7579081		13	0198820	7579286
	8a	0199013	7579006		14	0198809	7579246
	8b	0199013	7579006		15	0198811	7579210
	9a	0199102	7578996		16	0198830	7579182
	9b	0199102	7578996		17	0198873	7579167
	10a	0199179	7578990		18	0198751	7579280
	10b	0199179	7578990		19	0198756	7579283

	11a	0199217	7578990		20	0198701	7579289
	11b	0199217	7578990		21	0198653	7579278
	12a	0199291	7578974		22	0198625	7579249
	12b	0199282	7578951		23	0198602	7579219
	12c	0199333	7578963		24	0198583	7579177
					25	0198539	7579160

*Please note that the co-ordinates are in UTMs (GDA 94).

APPENDIX C

Motion Camera Coordinates-

Dates and Number of Nights Set

Motion Camera No.	Dates Set Up (Number of Nights On)	Easting*	Northing*
1 +	8th – 13th April 2015 (5)	0199851	7577636
2	9th – 12th April 2015 (3)	0199983	7777344
3	9th – 12th April 2015 (3)	0200130	7577799
4	10th – 13th April 2015 (3)	0199686	7577389
5	10th – 13th April 2015 (3)	0199832	7577613
6	10th – 13th April 2015 (3)	0200135	7577960
7	10th – 13th April 2015 (3)	0198751	7579280
8	10th – 13th April 2015 (3)	0198653	7579278

*Please note that the co-ordinates are in UTMs (GDA 94).

+Same location where previous Quoll was recorded on motion camera.

APPENDIX D

Northern Quoll Habitat Assessment Sheets

PILBARA NORTHERN QUOLL DATA SHEET – Habitat Survey

Site name: Beatons Creek, Nullagine	Recorder/s: Laura Stevens & Ron Firth
Date: 9/4/15 / Time: 11.30am	Contact email: ronfirth@360environmental.com.au
GPS datum: GDA94	GPS Accuracy: ±5m
Coordinates: 0200027, 7577638 (trap 14 of transect 1 lower)	

Please consider a 50m x 50m patch for all questions.

1. *LANDFORM ELEMENT*

Morphological type 13

C	*Crest*	F	*Flat*
U	*Upper slope*	V	*Open depression (vale)*
M	*Mid slope*	D	*Closed depression*
L	*Lower slope*	H	*Hillock*
S	*Simple slope*	R	*Ridge*

2. *ROCK OUTCROP*

TYPE (e.g. granite) Conglomerate

Abundance 101

0	*No bedrock exposed*	
1	*Very slightly rocky*	<2%
2	*Slightly rocky*	2-10%
3	*Rocky*	10-20%
4	*Very rocky*	20-50%
5	*Rockland*	>50%

3. *SOIL*

Colour

R	*Red*	Y	*Yellow*
O	*Orange*	G	*Grey*
B	*Brown*	D	*Dark*

Type 116

1	*Clay*	5	*Coarse sand*
2	*Fine silt*	6	*Fine gravel*
3	*Coarse silt*	7	*Coarse gravel*
4	*Fine sand*	8	*None; rock only*

4. *GROUND COVER*

% Cover Leaf Litter 5

% Cover Bare Ground 40
(including litter, rock cover and bare soil, excluding live vegetation)

5. *COARSE FRAGMENTS ON THE SURFACE*

Rock Abundance 97

0	*No coarse fragments*	0
1	*Very slightly; very few*	<2%
2	*Slightly; few*	2%-10%
3	*No qualifier; common*	10%-20%
4	*Moderately; many*	20%-50%
5	*Very; abundant*	50%-90%
6	*Extremely; very abundant*	>90%

Rock Size 99

3	*Gravelly*	>60 mm
4	*Cobbly; or cobbles*	60-200 mm
5	*Stony; stones*	200-600 mm
6	*Bouldery; or boulders*	600 mm-2 m
7	*Large boulders*	>2 m

6. *LAND SURFACE*

Disturbance of site 88

0	*No effective disturbance*
1	*No effective disturbance except grazing by hoofed animals*
2	*Limited clearing*
3	*Extensive clearing*
8	*Highly disturbed, e.g. mining, urban*

7. *EVIDENCE OF RECENT FIRE*

Frequency		**Intensity**	
0	*Long unburnt*	0	*No damage*
1	*Several years since burn*	1	*Minor*
2	*Burnt before last rainfall*	2	*Some defoliated*
3	*Burnt after last rainfall*	3	*Most defoliated*
		4	*Unknown*

Distance to nearest unburnt patch (>5 ha)

1	<100 m	2	100-500 m
3	500m – 1 km	4	>1 km

Patchiness, % of area burnt:

8. *NEARBY WATER BODIES*

		R	*River*
1	*Permanent*	S	*Soak/spring*
2	*Seasonal*	C	*Creek*
3	*Ephemeral*	P	*Pool*
		B	*Bore / windmill / dam*

Distance (m):

9. *EVIDENCE OF FERAL / INTRODUCED SPECIES (please list)*

none

Please collect any cat, dingo or quoll scats
Place into an envelope (not plastic),
label with collector's name, date, species, GPS location
and lodge with DPaW for dietary analysis.

10. *SITE PHOTOS (please attach)*

Photo number: See attached

Direction facing:

11. *VEGETATIVE GROWTH STAGE*

1	*Early regeneration*
2	*Advanced regeneration*
3	*Mature vegetation*
4	*Senescent phase*

12. *NATIVE FIG (FICUS) PRESENCE*

0	*Absent*
1	*1–10 plants*
2	*> 10 plants*

12. *VEGETATION*

Please tick 1 box in each row, and record dominant species where known		Absent	Isolated <2%	Very sparse 2–10%	Sparse 10–30%	Mid-Dense 30–70%	Dense 70–100%
TREES	**Dominant species**						
	> 30 m	✓					
	10–30 m	✓					
	<10 m			✓	Eucalyptus leucophloia		
MALLEES	**Dominant species**						
	Over 8 m	✓					
	Under 8m	✓					
SHRUBS	***Dominant species***						
	Over 2 m	~~✓~~			✓ Acacia species		
	1–2 m				✓ Acacia species		
	Under 1 m	✓					
HERBS & SEDGES	***Dominant species***						
		✓					
GRASSES	***Dominant species***						
	Hummock	~~✓~~				✓ Triodia species	
	Tussock	~~✓~~		✓		Cymbopogon species	
	Bunch	✓					

Version 3/04/14 1:59 PM

judy.dunlop@dpaw.wa.gov.au

PILBARA NORTHERN QUOLL DATA SHEET – Habitat Survey

Site name: Beetons Creek, Nullagine		Recorder/s: Laura Stevens & Ron Firth	
Date: 9/4/15	Time: 10.30am	Contact email: ronfirth@360environmental.com.au	
GPS datum: GDA94		GPS Accuracy: ± 5m	
Coordinates: 0199832, 7577613 (trap 13 of transect 1 upper)			

Please consider a 50m x 50m patch for all questions.

1. LANDFORM ELEMENT

Morphological type 13

C	Crest	F	Flat
U	Upper slope	V	Open depression (vale)
M	Mid slope	D	Closed depression
L	Lower slope	H	Hillock
S	Simple slope	R	Ridge

2. ROCK OUTCROP

TYPE (e.g. granite)

Abundance 101

0	No bedrock exposed	
1	Very slightly rocky	<2%
2	Slightly rocky	2-10%
3	Rocky	10-20%
4	Very rocky	20-50%
5	Rockland	>50%

3. SOIL

Colour

R	Red	Y	Yellow
O	Orange	G	Grey
B	Brown	D	Dark

Type 116

1	Clay	5	Coarse sand
2	Fine silt	6	Fine gravel
3	Coarse silt	7	Coarse gravel
4	Fine sand	8	None; rock only

4. GROUND COVER

% Cover Leaf Litter 10

% Cover Bare Ground 40
(including litter, rock cover and bare soil, excluding live vegetation)

5. COARSE FRAGMENTS ON THE SURFACE

Rock Abundance 97

0	No coarse fragments	0
1	Very slightly; very few	<2%
2	Slightly; few	2%-10%
3	No qualifier; common	10%-20%
4	Moderately; many	20%-50%
5	Very; abundant	50%-90%
6	Extremely; very abundant	>90%

Rock Size 99

3	Gravelly	>60 mm
4	Cobbly; or cobbles	60-200 mm
5	Stony; stones	200-600 mm
6	Bouldery; or boulders	600 mm-2 m
7	Large boulders	>2 m

6. LAND SURFACE

Disturbance of site 88

0	No effective disturbance
1	No effective disturbance except grazing by hoofed animals
2	Limited clearing
3	Extensive clearing
8	Highly disturbed, e.g. mining, urban

7. EVIDENCE OF RECENT FIRE

Frequency

0	Long unburnt
1	Several years since burn
2	Burnt before last rainfall
3	Burnt after last rainfall

Intensity

0	No damage
1	Minor
2	Some defoliated
3	Most defoliated
4	Unknown

Distance to nearest unburnt patch (>5 ha)

1	<100 m	2	100-500 m
3	500m – 1 km	4	>1 km

Patchiness, % of area burnt:

8. NEARBY WATER BODIES

		R	River
1	Permanent	S	Soak/spring
2	Seasonal	C	Creek
3	Ephemeral	P	Pool
		B	Bore / windmill / dam

Distance (m):

9. EVIDENCE OF FERAL / INTRODUCED SPECIES (please list)

none

Please collect any cat, dingo or quoll scats
Place into an envelope (not plastic),
label with collector's name, date, species, GPS location
and lodge with DPaW for dietary analysis.

10. SITE PHOTOS (please attach)

Photo number: see attached

Direction facing:

11. VEGETATIVE GROWTH STAGE

1	Early regeneration
2	Advanced regeneration
3	Mature vegetation
4	Senescent phase

12. NATIVE FIG (FICUS) PRESENCE

0	Absent
1	1–10 plants
2	> 10 plants

12. *VEGETATION*

Please tick 1 box in each row, and record dominant species where known		Absent	Isolated <2%	Very sparse 2–10%	Sparse 10–30%	Mid-Dense 30–70%	Dense 70–100%
TREES	**Dominant species**						
	> 30 m	✓					
	10–30 m	✓					
	<10 m			✓	Eucalyptus leucophloia		
MALLEES	**Dominant species**						
	Over 8 m	✓					
	Under 8m	✓					
SHRUBS	***Dominant species***						
	Over 2 m				✓ Acacia	species	
	1–2 m				✓ Acacia	species	
	Under 1 m	✓					
HERBS & SEDGES	***Dominant species***						
		✓					
GRASSES	***Dominant species***						
	Hummock	~~✓~~				✓ Triodia species	
	Tussock	~~✓~~		✓	Cymbopogon species		
	Bunch						

judy.dunlop@dpaw.wa.gov.au

PILBARA NORTHERN QUOLL DATA SHEET – Habitat Survey

Site name: Beatons Creek, Nullagine		Recorder/s: Laura Stevens & Ron Firth	
Date: 11/4/15	Time: 11.30am	Contact email: ronfirth@360environmental.com.au	
GPS datum: GDA94		GPS Accuracy: ± 5m	
Coordinates: 0198820, 7579286 (trap 13 of transect 2 lower)			

Please consider a 50m x 50m patch for all questions.

1. *LANDFORM ELEMENT*

Morphological type 13

C	*Crest*	F	*Flat*
U	*Upper slope*	V	*Open depression (vale)*
M	*Mid slope*	D	*Closed depression*
L	*Lower slope*	H	*Hillock*
S	*Simple slope*	R	*Ridge*

2. *ROCK OUTCROP*

TYPE (e.g. granite)

Abundance 101

0	*No bedrock exposed*	
1	*Very slightly rocky*	<2%
2	*Slightly rocky*	2-10%
3	*Rocky*	10-20%
4	*Very rocky*	20-50%
5	*Rockland*	>50%

3. *SOIL*

Colour

R	*Red*	Y	*Yellow*
O	*Orange*	G	*Grey*
B	*Brown*	D	*Dark*

Type 116

1	*Clay*	5	*Coarse sand*
2	*Fine silt*	6	*Fine gravel*
3	*Coarse silt*	7	*Coarse gravel*
4	*Fine sand*	8	*None; rock only*

4. *GROUND COVER*

% Cover Leaf Litter 5

% Cover Bare Ground 60
(including litter, rock cover and bare soil, excluding live vegetation)

5. *COARSE FRAGMENTS ON THE SURFACE*

Rock Abundance 97

0	*No coarse fragments*	0
1	*Very slightly; very few*	<2%
2	*Slightly; few*	2%-10%
3	*No qualifier; common*	10%-20%
4	*Moderately; many*	20%-50%
5	*Very; abundant*	50%-90%
6	*Extremely; very abundant*	>90%

Rock Size 99

3	*Gravelly*	>60 mm
4	*Cobbly; or cobbles*	60-200 mm
5	*Stony; stones*	200-600 mm
6	*Bouldery; or boulders*	600 mm-2 m
7	*Large boulders*	>2 m

6. *LAND SURFACE*

Disturbance of site 88

0	*No effective disturbance*
1	*No effective disturbance except grazing by hoofed animals*
2	*Limited clearing*
3	*Extensive clearing*
8	*Highly disturbed, e.g. mining, urban*

7. *EVIDENCE OF RECENT FIRE*

Frequency

0	*Long unburnt*
1	*Several years since burn*
2	*Burnt before last rainfall*
3	*Burnt after last rainfall*

Intensity

0	*No damage*
1	*Minor*
2	*Some defoliated*
3	*Most defoliated*
4	*Unknown*

Distance to nearest unburnt patch (>5 ha)

1	<100 m	2	100-500 m
3	500m – 1 km	4	>1 km

Patchiness, % of area burnt:

8. *NEARBY WATER BODIES*

		R	*River*
1	*Permanent*	S	*Soak/spring*
2	*Seasonal*	C	*Creek*
3	*Ephemeral*	P	*Pool*
		B	*Bore / windmill / dam*

Distance (m):

9. *EVIDENCE OF FERAL / INTRODUCED SPECIES (please list)*

none

Please collect any cat, dingo or quoll scats
Place into an envelope (not plastic),
label with collector's name, date, species, GPS location
and lodge with DPaW for dietary analysis.

10. *SITE PHOTOS (please attach)*

Photo number: See attached

Direction facing:

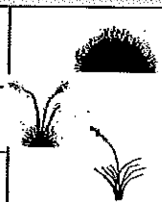
11. *VEGETATIVE GROWTH STAGE*

1	*Early regeneration*
2	*Advanced regeneration*
3	*Mature vegetation*
4	*Senescent phase*

12. *NATIVE FIG (FICUS) PRESENCE*

0	*Absent*
1	*1–10 plants*
2	*> 10 plants*

12. ***VEGETATION***

Please tick 1 box in each row, and record dominant species where known			**Absent**	**Isolated <2%**	**Very sparse 2–10%**	**Sparse 10–30%**	**Mid-Dense 30–70%**	**Dense 70–100%**
TREES	**Dominant species**							
	> 30 m		✓					
	10–30 m		✓					
	<10 m			✓				
MALLEES	**Dominant species**							
	Over 8 m		✓					
	Under 8m		✓					
SHRUBS	***Dominant species***							
	Over 2 m		✓					
	1–2 m			✓	Acacia species			
	Under 1 m			✓				
HERBS & SEDGES	***Dominant species***							
			✓					
GRASSES	***Dominant species***							
	Hummock					✓	Triodia species	
	Tussock				✓			
	Bunch				✓			

judy.dunlop@dpaw.wa.gov.au

PILBARA NORTHERN QUOLL DATA SHEET – Habitat Survey

Site name: Beatons Creek, Nullagine		Recorder/s: Laura Stevens & Ron Firth	
Date: 10/4/15	Time: 11am	Contact email: ronfirth@360environmental.com.au	
GPS datum: GDA94		GPS Accuracy: ± 5m	
Coordinates: 0198986, 7579379 (top bank of transect 2 upper)			

Please consider a 50m x 50m patch for all questions.

1. LANDFORM ELEMENT

Morphological type 13

C	*Crest*	F	*Flat*
U	*Upper slope*	V	*Open depression (vale)*
M	*Mid slope*	D	*Closed depression*
L	*Lower slope*	H	*Hillock*
S	*Simple slope*	R	*Ridge*

2. ROCK OUTCROP

TYPE (e.g. granite)

Abundance 101

0	*No bedrock exposed*	
1	*Very slightly rocky*	<2%
2	*Slightly rocky*	2-10%
3	*Rocky*	10-20%
4	*Very rocky*	20-50%
5	*Rockland*	>50%

3. SOIL

Colour

R	*Red*	Y	*Yellow*
O	*Orange*	G	*Grey*
B	*Brown*	D	*Dark*

Type 116

1	*Clay*	5	*Coarse sand*
2	*Fine silt*	6	*Fine gravel*
3	*Coarse silt*	7	*Coarse gravel*
4	*Fine sand*	8	*None; rock only*

4. GROUND COVER

% Cover Leaf Litter 10

% Cover Bare Ground 40
(Including litter, rock cover
and bare soil, excluding live vegetation)

5. COARSE FRAGMENTS ON THE SURFACE

Rock Abundance 97

0	*No coarse fragments*	0
1	*Very slightly; very few*	<2%
2	*Slightly; few*	2%-10%
3	*No qualifier; common*	10%-20%
4	*Moderately; many*	20%-50%
5	*Very; abundant*	50%-90%
6	*Extremely; very abundant*	>90%

Rock Size 99

3	*Gravelly*	>60 mm
4	*Cobbly; or cobbles*	60-200 mm
5	*Stony; stones*	200-600 mm
6	*Bouldery; or boulders*	600 mm-2 m
7	*Large boulders*	>2 m

6. LAND SURFACE

Disturbance of site 88

0	*No effective disturbance*
1	*No effective disturbance except grazing by hoofed animals*
2	*Limited clearing*
3	*Extensive clearing*
8	*Highly disturbed, e.g. mining, urban*

7. EVIDENCE OF RECENT FIRE

Frequency		**Intensity**	
0	*Long unburnt*	0	*No damage*
1	*Several years since burn*	1	*Minor*
2	*Burnt before last rainfall*	2	*Some defoliated*
3	*Burnt after last rainfall*	3	*Most defoliated*
		4	*Unknown*

Distance to nearest unburnt patch (>5 ha)

1	<100 m	2	100-500 m
3	500m – 1 km	4	>1 km

Patchiness, % of area burnt:

8. NEARBY WATER BODIES

		R	*River*
1	*Permanent*	S	*Soak/spring*
2	*Seasonal*	C	*Creek*
3	*Ephemeral*	P	*Pool*
		B	*Bore / windmill / dam*

Distance (m):

9. EVIDENCE OF FERAL / INTRODUCED SPECIES (please list)

none

Please collect any cat, dingo or quoll scats
Place into an envelope (not plastic),
label with collector's name, date, species, GPS location
and lodge with DPaW for dietary analysis.

10. SITE PHOTOS (please attach)

Photo number: see attached

Direction facing:

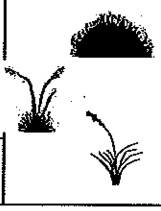
11. VEGETATIVE GROWTH STAGE

1	*Early regeneration*
2	*Advanced regeneration*
3	*Mature vegetation*
4	*Senescent phase*

12. NATIVE FIG (FICUS) PRESENCE

0	*Absent*
1	*1–10 plants*
2	*> 10 plants*

12. *VEGETATION*

Please tick 1 box in each row, and record dominant species where known			Absent	Isolated <2%	Very sparse 2–10%	Sparse 10–30%	Mid-Dense 30–70%	Dense 70–100%
TREES	**Dominant species**							
	> 30 m		✓					
	10–30 m		✓					
	<10 m			✓	Eucalyptus leucophloia			
MALLEES	**Dominant species**							
	Over 8 m		✓					
	Under 8m		✓					
SHRUBS	***Dominant species***							
	Over 2 m			✓	Acacia species			
	1–2 m							
	Under 1 m						✓	
HERBS & SEDGES	***Dominant species***							
			✓					
GRASSES	***Dominant species***							
	Hummock						✓	Triodia species
	Tussock		✓					
	Bunch		✓					

judy.dunlop@dpaw.wa.gov.au

PILBARA NORTHERN QUOLL DATA SHEET – Habitat Survey

Site name: Beatons Creek, Nullagine	Recorder/s: Laura Stevens & Ron Firth
Date: 12/4/15 Time: 4pm	Contact email: ronfirth@360environmental.com.au
GPS datum: GDA94	GPS Accuracy: ± 5m
Coordinates: 0199851, 7577636 (adjacent to adit where Quoll was recorded on motion camera in October 2014)	

Please consider a 50m x 50m patch for all questions.

1. LANDFORM ELEMENT

Morphological type 13

C	Crest	F	Flat
U	Upper slope	V	Open depression (vale)
M	Mid slope	D	Closed depression
L	Lower slope	H	Hillock
S	Simple slope	R	Ridge

2. ROCK OUTCROP

TYPE (e.g. granite)

Abundance 101

0	No bedrock exposed	
1	Very slightly rocky	<2%
2	Slightly rocky	2-10%
3	Rocky	10-20%
4	Very rocky	20-50%
5	Rockland	>50%

3. SOIL

Colour

R	Red	Y	Yellow
O	Orange	G	Grey
B	Brown	D	Dark

Type 116

1	Clay	5	Coarse sand
2	Fine silt	6	Fine gravel
3	Coarse silt	7	Coarse gravel
4	Fine sand	8	None; rock only

4. GROUND COVER

% Cover Leaf Litter 10

% Cover Bare Ground 50
(including litter, rock cover and bare soil, excluding live vegetation)

5. COARSE FRAGMENTS ON THE SURFACE

Rock Abundance 97

0	No coarse fragments	0
1	Very slightly; very few	<2%
2	Slightly; few	2%-10%
3	No qualifier; common	10%-20%
4	Moderately; many	20%-50%
5	Very; abundant	50%-90%
6	Extremely; very abundant	>90%

Rock Size 99

3	Gravelly	>60 mm
4	Cobbly; or cobbles	60-200 mm
5	Stony; stones	200-600 mm
6	Bouldery; or boulders	600 mm-2 m
7	Large boulders	>2 m

6. LAND SURFACE

Disturbance of site 88

0	No effective disturbance
1	No effective disturbance except grazing by hoofed animals
2	Limited clearing
3	Extensive clearing
8	Highly disturbed, e.g. mining, urban

7. EVIDENCE OF RECENT FIRE

Frequency		Intensity	
0	Long unburnt	0	No damage
1	Several years since burn	1	Minor
2	Burnt before last rainfall	2	Some defoliated
3	Burnt after last rainfall	3	Most defoliated
		4	Unknown

Distance to nearest unburnt patch (>5 ha)

1	<100 m	2	100-500 m
3	500m – 1 km	4	>1 km

Patchiness, % of area burnt:

8. NEARBY WATER BODIES

		R	River
1	Permanent	S	Soak/spring
2	Seasonal	C	Creek
3	Ephemeral	P	Pool
		B	Bore / windmill / dam

Distance (m):

9. EVIDENCE OF FERAL / INTRODUCED SPECIES (please list)

none

Please collect any cat, dingo or quoll scats
Place into an envelope (not plastic),
label with collector's name, date, species, GPS location
and lodge with DPaW for dietary analysis.

10. SITE PHOTOS (please attach)

Photo number: see attached

Direction facing:

11. VEGETATIVE GROWTH STAGE

1	Early regeneration
2	Advanced regeneration
3	Mature vegetation
4	Senescent phase

12. NATIVE FIG (FICUS) PRESENCE

0	Absent
1	1–10 plants
2	> 10 plants

12. *VEGETATION*

Please tick 1 box in each row, and record dominant species where known			**Absent**	**Isolated <2%**	**Very sparse 2–10%**	**Sparse 10–30%**	**Mid-Dense 30–70%**	**Dense 70–100%**
TREES	**Dominant species**							
	> 30 m		✓					
	10–30 m		✓					
	<10 m			✓	Ficus brachypoda Eucalyptus sp.			
MALLEES	**Dominant species**							
	Over 8 m		✓					
	Under 8m		✓					
SHRUBS	***Dominant species***							
	Over 2 m				✓	Acacia species		
	1–2 m				✓	Acacia species		
	Under 1 m			✓				
HERBS & SEDGES	***Dominant species***							
			✓					
GRASSES	***Dominant species***							
	Hummock					✓ Triodia species		
	Tussock		✓					
	Bunch		✓					

Version 3/04/14 1:59 PM

judy.dunlop@dpaw.wa.gov.au

APPENDIX E

EPBC Protected Matters Search

Australian Government
Department of the Environment

EPBC Act Protected Matters Report

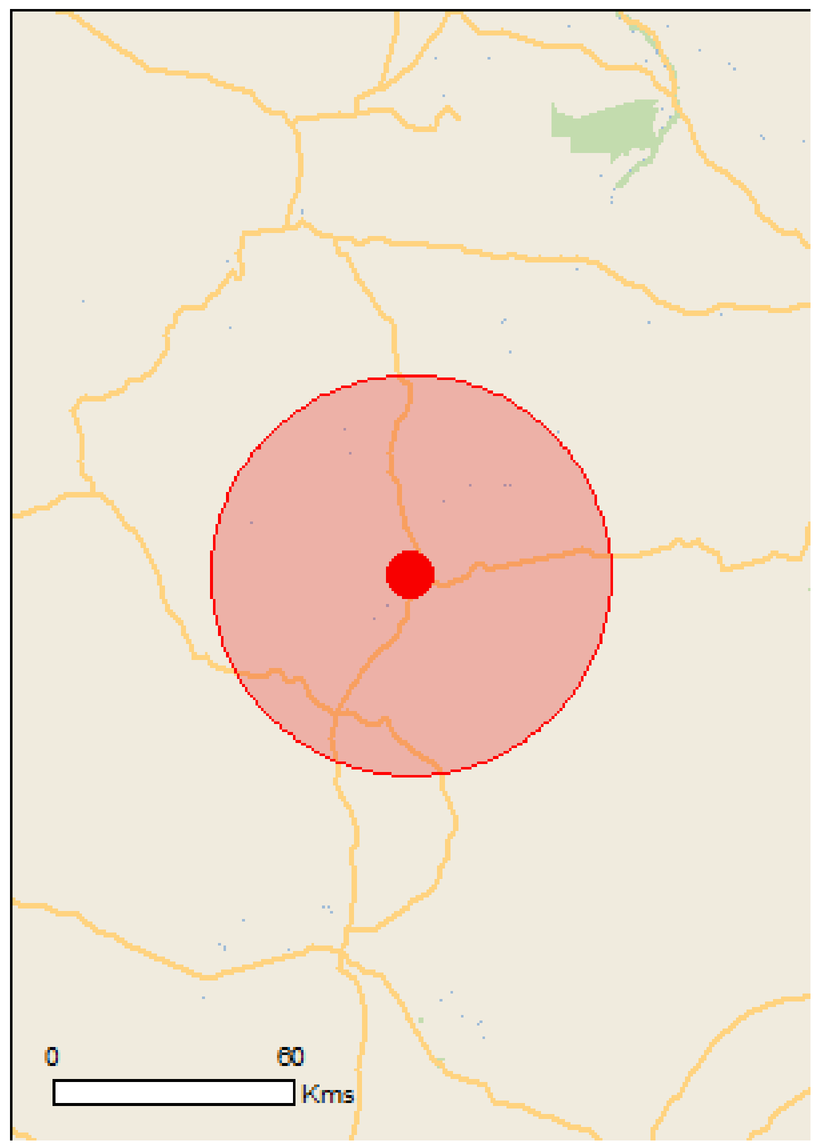
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

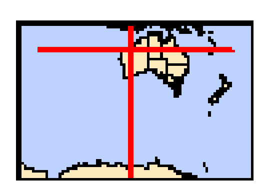
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 18/11/14 19:58:52

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates
Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	9
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	8
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

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

Place on the RNE:	3
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	13
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus Kakarratul, Northern Marsupial Mole [295]	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Lepidium catapycnon Hamersley Lepidium, Hamersley Catapycnon [9397]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Merops ornatus](#)		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Pandion haliaetus](#)		
Osprey [952]		Species or species habitat may occur within area
[Rostratula benghalensis (sensu lato)](#)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Garden Pool Geological Site	WA	Indicative Place
Historic		
Bonney Downs Homestead	WA	Indicative Place
Conglomerate Hotel	WA	Indicative Place

State and Territory Reserves [Resource Information]

Name	State
Meenthena Station	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius		
Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus		
Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus		
Horse [5]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Coordinates

-21.88641 120.10808

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX F

DPaW Threatened Fauna Search

NAME	SOURCE_CODE	SOURCE_ID	NAME_ID	FAMILY	GENUS	SPECIES	INFRARANK	INFRANAME	AUTHOR	VERNACULAR	KINGDOM	CONSV_CODE	CLASS	LOCALITY_NAME	SITE_NAME	DAY	MONTH	YEAR
Dasyurus hallucatus	FAUNASURVEY	253971	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	13	08	2011
Dasyurus hallucatus	FAUNASURVEY	424628	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	05	03	2012
Dasyurus hallucatus	TFAUNA	14030	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	NULLAGINE	01	01	1979
Dasyurus hallucatus	FAUNASURVEY	487625	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek	07	08	2012
Dasyurus hallucatus	FAUNASURVEY	424623	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: CAM REC1 D3	05	03	2012
Dasyurus hallucatus	FAUNASURVEY	424625	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: NewGully	06	03	2012
Dasyurus hallucatus	FAUNASURVEY	253966	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	07	08	2011
Dasyurus hallucatus	FAUNASURVEY	487623	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek	07	08	2012
Dasyurus hallucatus	FAUNASURVEY	253970	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	Blue Spec	12	08	2011
Dasyurus hallucatus	FAUNASURVEY	424627	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	04	03	2012
Dasyurus hallucatus	FAUNASURVEY	424626	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SSP	03	03	2012
Dasyurus hallucatus	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M24352	24093	Dasyuridae	Dasyurus	hallucatus			Gould	Northern Quoll	Animalia	T	MAMMAL	NULLAGINE		09	12	1899
Falco hypoleucos	TFAUNA	3211	24473	Falconidae	Falco	hypoleucos			Gould	Grey Falcon	Animalia	T	BIRD	NULLAGINE	Nullagine	19	05	1994
Falco hypoleucos	TFAUNA	3695	24473	Falconidae	Falco	hypoleucos			Gould	Grey Falcon	Animalia	T	BIRD	NULLAGINE	Nullagine	12	11	1997
Liasis olivaceus subsp. barroni	FAUNASURVEY	256393	25238	Boidae	Liasis	olivaceus	subsp.	barroni	Smith	Pilbara Olive Python	Animalia	T	REPTILE	NULLAGINE	BonnieDowns	03	06	2011
Macrotis lagotis	FAUNASURVEY	668307	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	FAUNASURVEY	668305	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	TFAUNA	21167	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Pilbara	23	08	2012
Macrotis lagotis	FAUNASURVEY	153905	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	MMB1	02	09	2010
Macrotis lagotis	FAUNASURVEY	668306	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Mt Webber	03	07	2013
Macrotis lagotis	TFAUNA	3749	24168	Thylacomyidae	Macrotis	lagotis			(Reid)	Bilby, Dalgyte	Animalia	T	MAMMAL	NULLAGINE	Nullagine	14	06	1979
Rhinonicteris aurantia	TFAUNA	12732	43368	Hipposideridae	Rhinonicteris	aurantia			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Nullagine	23	08	2006
Rhinonicteris aurantius	FAUNASURVEY	472434	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	MARBLE BAR	Uncle Toms Mine	08	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472416	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472419	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	425280	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SM2 06 D2	01	03	2012
Rhinonicteris aurantius	FAUNASURVEY	472427	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	06	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472421	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	09	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472423	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472430	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Marble Bar Road	09	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472422	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Rhinonicteris aurantius	FAUNASURVEY	425279	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek: SM2 01 D2	01	03	2012
Rhinonicteris aurantius	FAUNASURVEY	472428	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	07	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472426	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	07	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472425	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Corunna Downs Station	06	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472417	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472420	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	02	05	2012
Rhinonicteris aurantius	FAUNASURVEY	472424	24179	Hipposideridae	Rhinonicteris	aurantius			Gray	Orange Leafnosed-bat	Animalia	T	MAMMAL	NULLAGINE	Copper Hills Mine	03	05	2012
Ardea modesta	BIRDATLAS2	5074141|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Nullagine	30	10	2010
Ardea modesta	BIRDATLAS2	449236|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Nullagine	25	06	2004
Ardea modesta	BIRDATLAS2	412391|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Garden Pool	20	07	2003
Ardea modesta	BIRDATLAS2	776174|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Mine Pools	13	08	2007
Ardea modesta	BIRDATLAS2	776173|187	41324	Ardeidae	Ardea	modesta			J.E. Gray	Eastern Great Egret	Animalia	IA	BIRD	NULLAGINE	Garden Pool	11	08	2007
Calidris acuminata	BIRDATLAS2	5072299|163	24779	Scolopacidae	Calidris	acuminata			(Horsfield)	Sharp-tailed Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullargine Lagoon	30	10	2010
Merops ornatus	BIRDATLAS1	20938|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE		10	06	1977
Merops ornatus	BIRDATLAS2	160979|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool, Nullagine	09	07	2001
Merops ornatus	BIRDATLAS2	460783|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine River	06	09	2005
Merops ornatus	BIRDATLAS2	5031170|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	GardenPool near Nullagine	13	09	2008
Merops ornatus	BIRDATLAS2	460779|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine River, Garden Pool	24	07	2005
Merops ornatus	BIRDATLAS2	412391|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	20	07	2003
Merops ornatus	BIRDATLAS1	82615|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE		25	09	1979
Merops ornatus	BIRDATLAS2	275822|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine Road	27	06	2001
Merops ornatus	BIRDATLAS2	449237|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Nullagine R Garden Pool	25	06	2004
Merops ornatus	BIRDATLAS2	776119|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	09	08	2006
Merops ornatus	BIRDATLAS2	286770|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	24	07	2002
Merops ornatus	FAUNASURVEY	425137	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	04	03	2012
Merops ornatus	FAUNASURVEY	425144	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	03	03	2012
Merops ornatus	FAUNASURVEY	425150	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	04	03	2012
Merops ornatus	FAUNASURVEY	153965	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	01	09	2010
Merops ornatus	FAUNASURVEY	153951	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	20	05	2010
Merops ornatus	FAUNASURVEY	668436	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	07	07	2013
Merops ornatus	FAUNASURVEY	425135	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	01	03	2012
Merops ornatus	FAUNASURVEY	425136	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	02	03	2012
Merops ornatus	FAUNASURVEY	153963	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB3	30	08	2010
Merops ornatus	FAUNASURVEY	425146	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	05	03	2012
Merops ornatus	FAUNASURVEY	668434	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	07	07	2013
Merops ornatus	FAUNASURVEY	153955	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS2	21	05	2010
Merops ornatus	FAUNASURVEY	425134	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 1	02	03	2012
Merops ornatus	FAUNASURVEY	153959	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	24	05	2010
Merops ornatus	FAUNASURVEY	153952	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	20	05	2010
Merops ornatus	FAUNASURVEY	153960	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF4	24	05	2010
Merops ornatus	FAUNASURVEY	425151	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	05	03	2012
Merops ornatus	FAUNASURVEY	425153	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	02	03	2012
Merops ornatus	BIRDATLAS2	776173|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Garden Pool	11	08	2007
Merops ornatus	FAUNASURVEY	425143	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	03	03	2012
Merops ornatus	FAUNASURVEY	425141	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	07	03	2012
Merops ornatus	FAUNASURVEY	425138	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: IRT 3	05	03	2012
Merops ornatus	FAUNASURVEY	425130	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: Calcrete	07	03	2012
Merops ornatus	FAUNASURVEY	153961	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	24	05	2010
Merops ornatus	FAUNASURVEY	153966	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	01	09	2010
Merops ornatus	FAUNASURVEY	153950	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB1	20	05	2010
Merops ornatus	FAUNASURVEY	425132	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: CID	05	03	2012
Merops ornatus	FAUNASURVEY	153967	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB2	02	09	2010
Merops ornatus	BIRDATLAS2	281283|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	146 Bonney downs	02	09	2002
Merops ornatus	FAUNASURVEY	153958	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	23	05	2010
Merops ornatus	FAUNASURVEY	153962	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMS1	25	05	2010
Merops ornatus	FAUNASURVEY	153954	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	21	05	2010
Merops ornatus	FAUNASURVEY	153968	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	02	09	2010
Merops ornatus	FAUNASURVEY	425147	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: RRG 1	07	03	2012
Merops ornatus	FAUNASURVEY	425148	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: SSP	01	03	2012
Merops ornatus	BIRDATLAS2	476246|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Noreena-Roy Hill Rd	07	06	2006
Merops ornatus	FAUNASURVEY	668435	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Mt Webber	04	07	2013
Merops ornatus	BIRDATLAS2	476295|329	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	Cajaput Creek	17	06	2006
Merops ornatus	FAUNASURVEY	153956	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMB4	22	05	2010
Merops ornatus	FAUNASURVEY	425142	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	08	03	2012
Merops ornatus	FAUNASURVEY	425129	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	McPhee Creek: Calcrete	04	03	2012
Merops ornatus	FAUNASURVEY	153953	24598	Meropidae	Merops	ornatus			Latham	Rainbow Bee-eater	Animalia	IA	BIRD	NULLAGINE	MMF3	20	05	2010
Tringa glareola	BIRDATLAS2	5074141|154	24806	Scolopacidae	Tringa	glareola			Linnaeus	Wood Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullagine	30	10	2010
Tringa glareola	BIRDATLAS2	5072299|154	24806	Scolopacidae	Tringa	glareola			Linnaeus	Wood Sandpiper	Animalia	IA	BIRD	NULLAGINE	Nullargine Lagoon	30	10	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166162	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	07	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153600	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	21	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166159	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	03	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153599	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB4	20	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166167	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	11	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166165	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	07	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166166	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	16	09	2006
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166161	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	09	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153604	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	23	05	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166163	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	12	09	2006
Ctenotus nigrilineatus	FAUNASURVEY	153605	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB4	25	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153601	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB2	22	05	2010

Ctenotus nigrilineatus	FAUNASURVEY	153610	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	02	09	2010
Ctenotus nigrilineatus	FAUNASURVEY	153602	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	23	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153607	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF4	31	08	2010
Ctenotus nigrilineatus	FAUNASURVEY	153597	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMF1	03	05	2010
Ctenotus nigrilineatus	FAUNASURVEY	153606	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	30	08	2010
Ctenotus nigrilineatus	WAM_REPTILES	urn:lsid:taxonomy.org.au:REPT:R166164	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	NULLAGINE	31	08	2006
Ctenotus nigrilineatus	FAUNASURVEY	153608	25058	Scincidae	Ctenotus	nigrilineatus			Storr	Black-lined Ctenotus, Pin-striped Fine-snout Skink	Animalia	1	REPTILE	NULLAGINE	MMB1	01	09	2010
Ninox connivens subsp. connivens	TFAUNA	11933	24819	Strigidae	Ninox	connivens	subsp.	connivens	(Latham)	Barking Owl (southwest pop P2), Barking Owl	Animalia	2	BIRD	NULLAGINE	Nullagine	28	12	2005
Ardeotis australis	BIRDATLAS1	82618|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE		13	08	1979
Ardeotis australis	BIRDATLAS2	113455|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Marble Bar Road	21	08	2000
Ardeotis australis	BIRDATLAS1	20938|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE		10	06	1977
Ardeotis australis	FAUNASURVEY	667656	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	04	07	2013
Ardeotis australis	FAUNASURVEY	244307	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert06	18	04	2011
Ardeotis australis	FAUNASURVEY	667658	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	03	07	2013
Ardeotis australis	BIRDATLAS2	776172|176	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Cajaput Creek	11	08	2007
Ardeotis australis	FAUNASURVEY	244308	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert06	01	04	2011
Ardeotis australis	FAUNASURVEY	244305	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Opportunistic Site 02	17	04	2011
Ardeotis australis	FAUNASURVEY	153447	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	MMS2	01	09	2010
Ardeotis australis	FAUNASURVEY	244309	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	977-Vert07	16	04	2011
Ardeotis australis	FAUNASURVEY	667657	24610	Otididae	Ardeotis	australis			(J.E. Gray)	Australian Bustard	Animalia	4	BIRD	NULLAGINE	Mt Webber	07	07	2013
Burhinus grallarius	BIRDATLAS2	776119|174	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Garden Pool	09	08	2006
Burhinus grallarius	FAUNASURVEY	424328	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	McPhee Creek: MC TARG1 0305	05	03	2012
Burhinus grallarius	FAUNASURVEY	667691	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Mt Webber	04	07	2013
Burhinus grallarius	FAUNASURVEY	667692	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	Mt Webber	05	07	2013
Burhinus grallarius	FAUNASURVEY	424329	24359	Burhinidae	Burhinus	grallarius			(Latham)	Bush Stone-curlew	Animalia	4	BIRD	NULLAGINE	McPhee Creek: No site (opportunistic)	29	02	2012
Dasycercus blythi	FAUNASURVEY	153665	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	MMB1	02	09	2010
Dasycercus blythi	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M2745	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	BLUE SPEC MINING CENTRE			
Dasycercus blythi	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3456	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE		26	05	1959
Dasycercus blythi	TFAUNA	16374	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	Nullagine	26	05	1959
Dasycercus blythi	FAUNASURVEY	153666	30903	Dasyuridae	Dasycercus	blythi			(Waite)	Brush-tailed Mulgara, Ampurta	Animalia	4	MAMMAL	NULLAGINE	MMB1	05	09	2010
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M15233	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	CAVE	26	08	1976
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3161	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3155	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3150	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	TFAUNA	12725	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Nullagine	08	09	2006
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M2553	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	ALL NATIONS MINE			
Macroderma gigas	FAUNASURVEY	424991	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: CID	04	03	2012
Macroderma gigas	FAUNASURVEY	472439	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	09	05	2012
Macroderma gigas	FAUNASURVEY	472440	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	10	09	2012
Macroderma gigas	TFAUNA	12723	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Nullagine	07	09	2006
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3163	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4802	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	ALL NATIONS MINE	09	12	1899
Macroderma gigas	FAUNASURVEY	472437	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3152	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3159	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3284	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE		09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4681	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,OLD	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3158	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	FAUNASURVEY	472438	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3162	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3151	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Macroderma gigas	FAUNASURVEY	472435	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	Lionel Mine	07	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M4683	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE		09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3156	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3160	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3153	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS	09	12	1899
Macroderma gigas	FAUNASURVEY	472436	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek Iron Ore Project	01	05	2012
Macroderma gigas	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M3149	24180	Megadermatidae	Macroderma	gigas			(Dobson)	Ghost Bat	Animalia	4	MAMMAL	NULLAGINE	MINE,ALL NATIONS.	09	12	1899
Pseudomys chapmani	FAUNASURVEY	244113	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	FAUNASURVEY	244112	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	FAUNASURVEY	425256	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: MY TARG1 0308	08	03	2012
Pseudomys chapmani	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M57928	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	21KM WNW BONNEY DOWNS HOMESTEAD	07	05	2005
Pseudomys chapmani	FAUNASURVEY	425255	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	McPhee Creek: MY TARG1 0308	08	03	2012
Pseudomys chapmani	TFAUNA	5333	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	Galteemore	01	01	1994
Pseudomys chapmani	FAUNASURVEY	244095	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	977-Vert07	13	04	2011
Pseudomys chapmani	TFAUNA	20674	24233	Muridae	Pseudomys	chapmani			Kitchener	Western Pebble-mound Mouse, Ngadji	Animalia	4	MAMMAL	NULLAGINE	Pilbara	18	03	1993
Sminthopsis longicaudata	WAM_MAMMALS	urn:lsid:taxonomy.org.au:MAMM:M57925	24115	Dasyuridae	Sminthopsis	longicaudata			Spencer	Long-tailed Dunnart	Animalia	4	MAMMAL	NULLAGINE	21KM WNW BONNEY DOWNS HOMESTEAD	05	05	2005

APPENDIX D

SRK Acid and Metalliferous Drainage (AMD) Assessment

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Project Memo

Client:	Novo Resources Corp.	**Date:**	26/10/2015
Attention:	Simon Pooley	**From:**	Russell Staines
Project No:	NOV001	**Revision No:**	0
Project Name:	Beatons Creek – AMD Assessment		
Subject:	Beatons Creek Oxide Material Acid and Metalliferous Drainage (AMD) Assessment		

1 Introduction

At the request of Mr Simon Pooley of Novo Resources Corp. (Novo), SRK Consulting (Australasia) Pty Ltd (SRK) carried out a geochemical assessment of potential waste rock and tailings associated with Novo's Beatons Creek gold project, located near Nullagine in the Pilbara region of Western Australia. Novo previously engaged Pendragon Environmental Solutions (Pendragon) to carry out a series of technical studies for the Beatons Creek project, including geochemistry and hydrogeology. The Pendragon investigations included materials characterisation for a wider range of locations than are included in current mine plans. Novo requires a geochemical assessment of the area to be mined, the outcomes of which will be required as input to the Mining Proposal submitted to the Department of Mines and Petroleum (DMP) and will assist with development of mine closure plans. This memo presents the results of SRK's geochemical assessment.

2 Background

Development of the Beatons Creek gold project will involve open strip mining of flat lying conglomerate reefs which lie within the Hardey Formation. The host rocks to the gold deposits at Beatons Creek occur towards the top of a >800 m thick sequence of poorly-stratified, poorly-sorted, polymictic, pebble to boulder conglomerate and lesser conglomeratic sandstone. The geomorphology of the area includes prominent ridges up to 30 m high separated by incised valleys, and the gold-bearing reefs outcrop within these ridges.

Although the Beatons Creek project includes a series of reefs which progress from an upper oxide zone into a deeper sulphide zone, current plans include mining from reefs in the oxide zone only. Mining will remove various depths of material, generally restricted to the upper 15-20 m. The oxide/ sulphide boundary is generally located at around 20-25 m in the zones to be mined. Individual reefs are up to 2 m thick and laterally extensive, with gold occurring in the conglomerate matrix. Mining will be by hydraulic/ mechanical methods, not requiring drill and blast.

Over a 6-year mine life, approximately 4 Mt of ore and 14 Mt of waste rock will be extracted, with the latter being stored in three valley fill waste rock dumps (WRDs). Tailings will be stored in a facility with a final area of approximately 46 ha and embankment height of 28 m.

The ridge and valley geomorphology of the site, along with proposed facility locations, is presented in Figure 2-1.

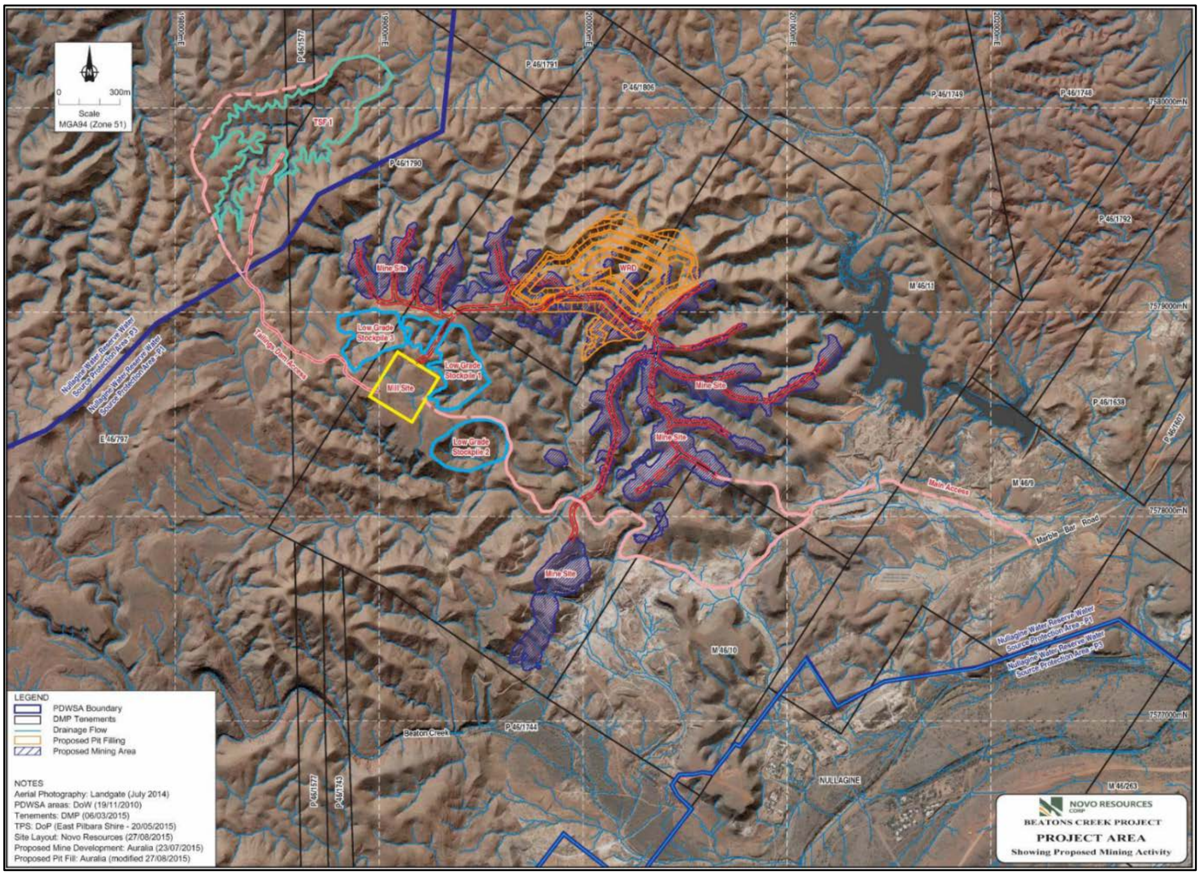


Figure 2-1: Site map

3 Methodology

The objective of the work presented herein was to extract information from existing geochemical data to facilitate assessment of the acid and metalliferous drainage (AMD) potential for materials produced during mining of the oxide ore zone at Beatons Creek.

To facilitate the AMD assessment, Novo provided the following:

- 3D mine planning information
- Multi-element data, from exploration and resource definition programmes
- Results from geochemical test work carried out by Pendragon (2015).

All relevant data were used to create a *Leapfrog Geo* project, which was used for the assessment of spatial coverage of existing data. Additionally, the use of *Leapfrog Geo* facilitated the extraction of specific categories of chemical data, i.e. all data from within the mass of material to be mined, separated into zones of waste and ore reefs.

Following extraction of data relevant to current mine plans, standard methods of AMD data processing and interpretation were employed.

4 Results

4.1 Sulphur data from Novo assay database

From within the volume to be mined, sulphur assay data were available for 150 samples from waste zones and 135 samples from within oxide ore reefs. Assay data were biased to the surface zone, with 96% of samples located in top 2m; there were limited data available to characterise material to be mined at greater depth within the oxide zone, i.e. in the 2-20 m range.

Histograms of sulphur concentrations are presented in Figure 4-1 for waste and Figure 4-2 for ore. In both categories, 95% of samples contained 0.1% sulphur or less, with 86% being less than 0.05% sulphur. Sulphur concentrations of <0.1% are commonly regarded as being representative of non-acid forming (NAF) material. Only two samples of waste and one of ore contained >0.3% sulphur, with all three in the range 0.35-0.39% S. In the absence of additional information, these samples with >0.3% sulphur may be considered as potentially acid forming (PAF).

The range of sulphur concentrations in the Novo assay database, for the mass to be mined, would generally be considered as low. In terms of an AMD assessment, to be conservative all sulphur could be considered as being present in potentially acid generating sulphides such as pyrite. As 96% of the Novo samples considered were collected in the upper 2 m of a 20-25 m oxide sequence, it is considered unlikely that significant quantities of sulphide would be present. It is more likely that the sulphur is present in an oxidised form, e.g. as sulfates or hydroxysulfates (this expectation is largely corroborated by available mineralogical data – Section 4.2.2).

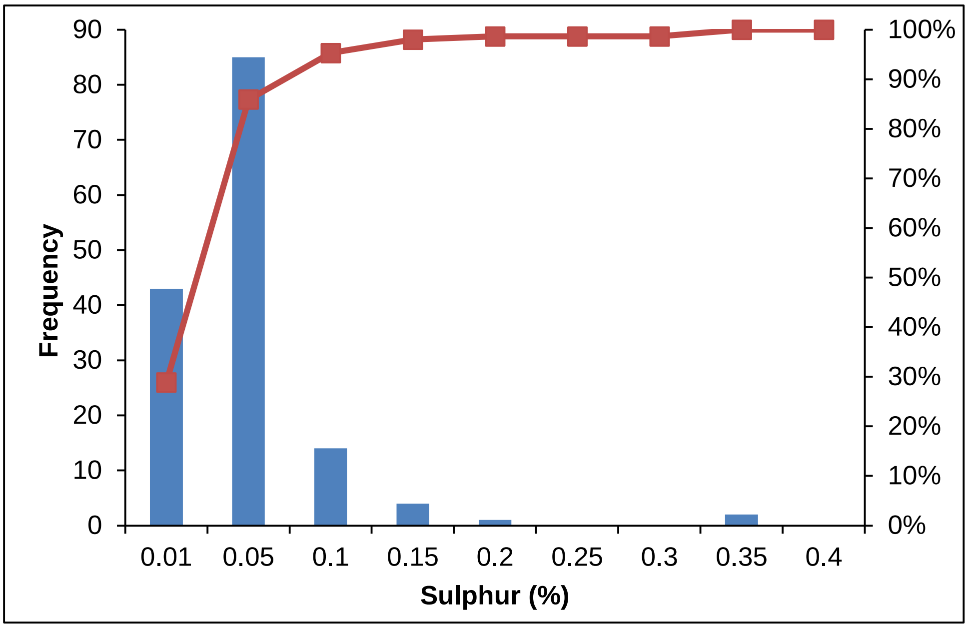


Figure 4-1: Sulphur concentrations in waste rock zone samples

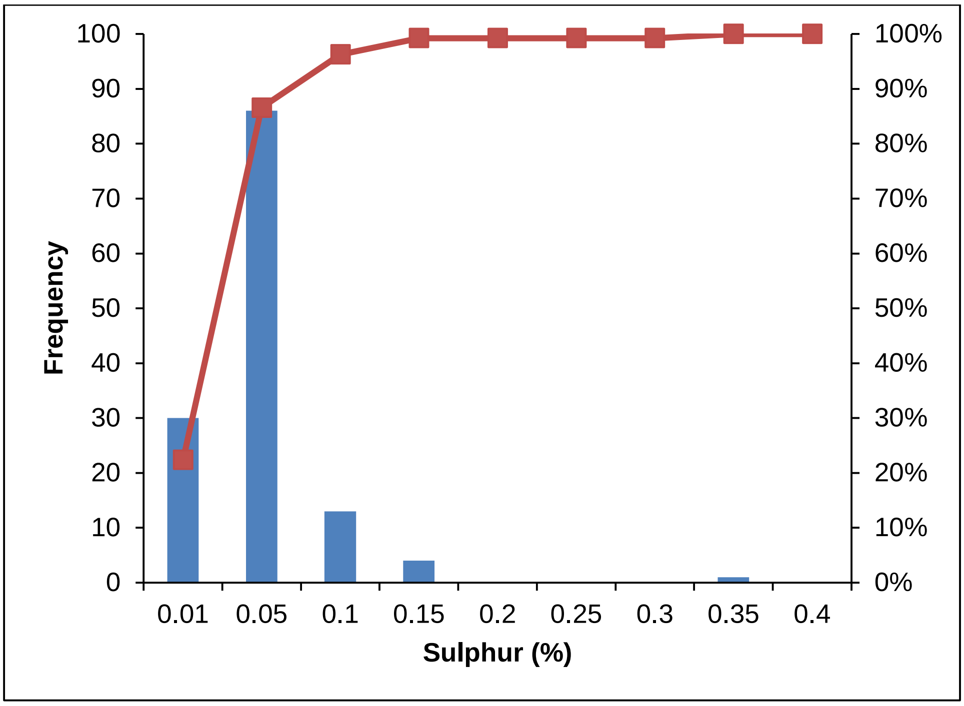


Figure 4-2: Sulphur concentrations in ore reef zone samples

4.2 AMD assessment data available from previous characterisation programme

Pendragon (2015) included AMD assessment of around 75 samples from both the oxide and sulphide zone at Beatons Creek. Data for all samples considered as relevant to the purposes of the current assessment were extracted. This includes data from 23 oxide zone waste samples and one sample from within a mineralised oxide reef. In addition, 10 samples from around or on the boundary between the oxide and sulphide zones are also discussed. Data from these samples were assessed, as a separate group, which may be indicative of conditions should mining proceed deeper than currently planned. Additionally, as current mine plans include a few locations where mining proceeds down to the oxide/ sulphide boundary, this sub-group of samples may be representative of conditions which could be encountered in the exposed surfaces at such locations.

4.2.1 Spatial distribution of data

The locations of the samples used in the current assessment are presented in Figure 4-3, along with the base surface down to which mining will proceed. As can be seen in Figure 4-3, the samples used for assessment lie within the zone to be mined (i.e. above the purple mine base surface) as well as below and adjacent to areas to be mined.

The spatial distribution of samples included is considered as adequate for the purpose of the current assessment. Samples have not been sub-divided into different lithological categories, as the geological logging indicates that lithological variation is not significant, being dominated by conglomerate.

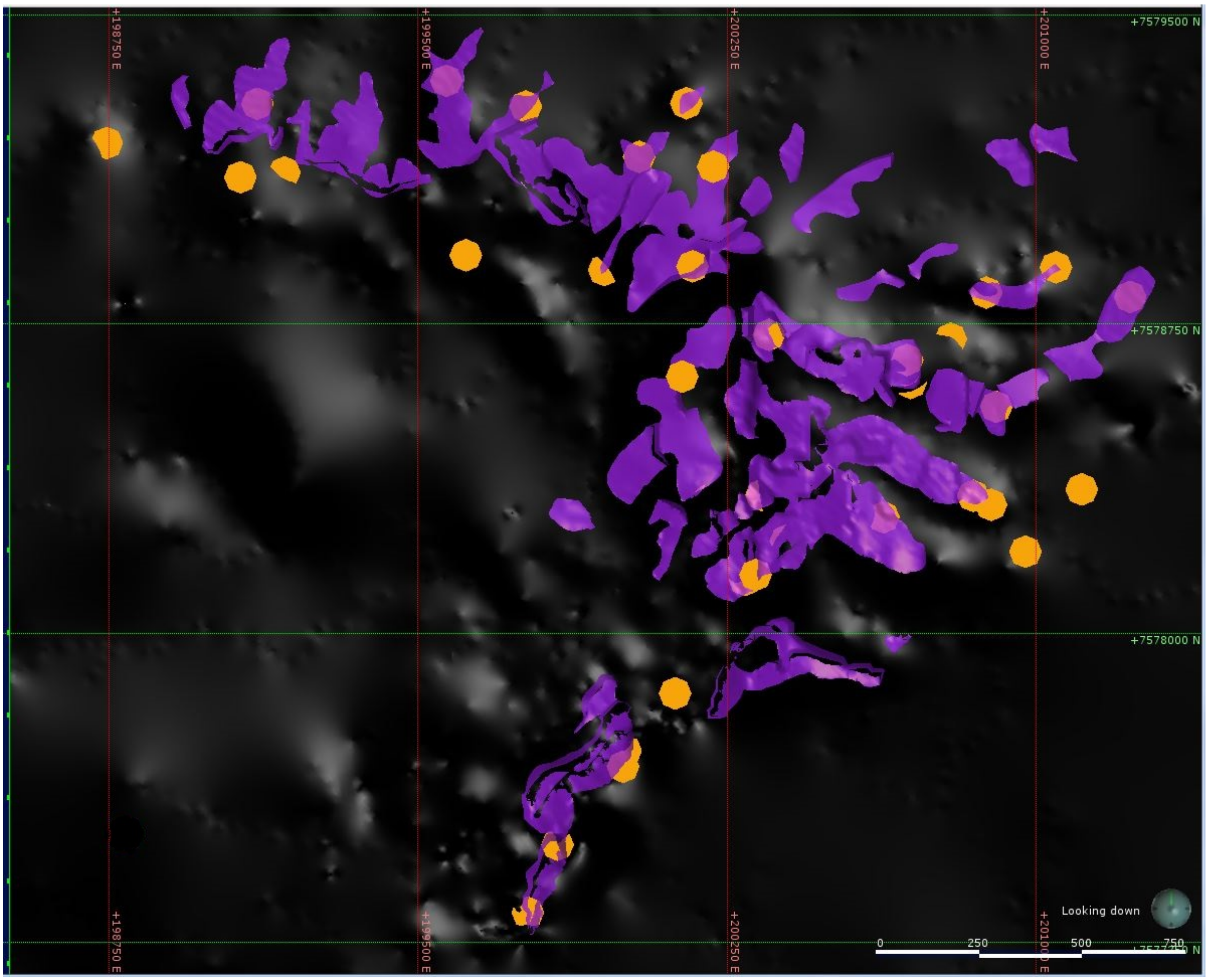


Figure 4-3: Sample locations (orange), base of mined area (purple) and oxide/ sulphide boundary (black)

4.2.2 Mineralogy

Mineralogical determination results for samples from one ore reef and six waste locations are presented in Table 4-1 which also includes data for two tailings samples. All samples are dominated by quartz, followed by illite/ muscovite. In AMD terms, key results are the presence of <1% pyrite in three waste samples and other sulphur containing minerals in several samples, including the reef sample; gypsum, jarosite, natroalunite and alunite. Of these latter oxidised sulphur minerals, jarosite and alunites can represent stored acidity. The absence of carbonates, such as calcite, which could be a readily available source of acid buffering, is also significant.

Table 4-1: Mineralogy results (all values are %)

Mineral	BCRC14-002 21-22	BCRC14-056 2-3	BCRC14-056 14-15	BCRC14-063 1-2	BCRC14-199 15-16	BCRC14-274 7-8	BCRC14-057 21-22 (Reef)	Tail-Novo	Tail-Gekko
Amorphous	5	5	1	2	5	8	6		4
Alunite	1		3	1			1		
Clinochlore					2	2			
Expanding clay			2				<1		
Goethite								<1	1
Gypsum				1					
Hematite	1	3	4	3	5	5	3	1	7
Illite/Muscovite	18	11	19	11	10	11	18	3	14
Jarosite							1		
Kaolin		2						8	
Natroalunite		3			1				
Potassium feldspar	2	2	2	2	1	1	2	2	
Pyrite	<1				<1	<1			
Pyrophyllite					7	4			
Quartz	74	72	69	79	67	68	67	84	73
Sodium Plagioclase		1	1	1	1	1	1	<1	

4.2.3 Acid Base Accounting (ABA)

Results from ABA testwork on samples representative of the material to be mined are presented in Table 4-2. Paste pH is indicative of the presence of readily soluble forms of acidity and neutralisation and the values in the waste samples ranged from pH 3.8-7.1, with a median of pH 4.6. The results suggest that a readily soluble source of acidity is present in some samples, with this being supported by negative acid neutralisation capacity (ANC) values in the samples with the lowest paste pH values. The ANC values were all low, with a maximum of 2 kg H_2SO_4/t recorded in four waste samples and one of the tailings samples.

Total sulphur concentrations ranged from 0.03-0.93%, i.e. extending to a higher maximum value than shown by the Novo assay database. This may indicate that greater sulphur contents occur at depth within the oxide zone (the Novo assay database being dominated by samples from the upper 2 m only). More data would be required to examine the spatial distribution of sulphur more robustly.

In the majority of samples, testing indicated that sulphur speciation was dominated by SO_4. Additionally, the hydrochloric acid digest method used in sulphate determination, commonly does not account for all sulphates, e.g. alunite may not be entirely dissolved. Therefore, the dominance of sulphate over other forms of sulphur may be greater than results indicate. Sulphide-S, taken as total-S minus SO_4-S, is used to calculate acidification potential (AP), under the assumption that all sulphide-S is present as acid generating sulphide. The AP values for all samples were <10 kg H_2SO_4/t, with a median value of 2.14 kg H_2SO_4/t, which would generally be considered as low.

Although AP values may generally be considered as low, the lack of readily available buffering capacity results in the majority of samples having a positive net acid production potential (NAPP), i.e. AP > ANC. It should be noted that some sulphate minerals (jarosite, alunite) can represent stored acidity.

Net acid generation (NAG) pH is a result of mixing the sample with an aggressive oxidant (hydrogen peroxide) which should oxidise sulphides and dissolve readily available buffering minerals such as calcite, thus giving a net result for the sample in terms of acid generation. As a guide, NAG pH <4.5 is considered as indicative of material which is likely to be of concern in terms of AMD generation. The median NAG pH in the samples assessed was pH 4.8, with a range of pH 4.2-6.8. The tailings samples recorded NAG pH values of pH 5.7 and 6.2.

Table 4-2: Results from ABA testwork

Drillhole		Depth (m) from	Depth (m) to	Paste pH	EC mS/cm	S %	$S\text{-}SO_4$ %	ANC kg H_2SO_4/t	AP kg H_2SO_4/t	NAPP kg H_2SO_4/t	NAG pH
BCRC14-	002	21	22	4.6	0.11	0.2	0.16	1	1.22	0.22	5
	004	4	5	7.1	0.13	0.04	0.03	2	0.31	-1.69	6
	008	14	15	4.9	0.1	0.15	0.12	1	0.92	-0.08	5
	022	2	3	5.9	0.07	0.04	0.02	1	0.61	-0.39	5.5
	035	21	22	3.8	0.73	0.51	0.4	-1	3.37	4.37	4.2
	038	21	22	4.1	0.49	0.3	0.23	-1	2.14	3.14	4.3
	045	12	13	4.3	0.24	0.33	0.22	0	3.37	3.37	4.7
	045	19	20	4.3	0.2	0.59	0.51	0	2.45	2.45	5
	047	21	22	4.7	0.11	0.19	0.13	0	1.84	1.84	4.6
	056	2	3	4.6	0.06	0.35	0.24	0	3.37	3.37	4.6
	056	14	15	4	0.3	0.5	0.39	-1	3.37	4.37	4.3
	063	1	2	5.9	1.36	0.37	0.28	0.01	2.75	2.74	4.8
	078	1	2	6.6	0.94	0.25	0.22	2	0.92	-1.08	6.8
	100	19	20	4.6	0.08	0.03	0.02	0	0.31	0.31	5.3
	109	11	12	4.8	0.53	0.53	0.28	2	7.65	5.65	4.8
	132	15	16	4.7	0.23	0.73	0.61	0	3.67	3.67	4.9
	151	17	18	4.4	0.19	0.21	0.15	0	1.84	1.84	4.9
	152	5	6	4.6	0.16	0.47	0.39	0	2.45	2.45	4.9
	177	11	12	3.8	0.66	0.93	0.65	-1	8.57	9.57	4.4
	199	15	16	3.9	0.92	0.34	0.29	-1	1.53	2.53	4.5
	274	7	8	5	0.16	0.18	0.15	2	0.92	-1.08	4.9
	298	17	18	4.3	0.3	0.45	0.36	0	2.75	2.75	4.6
	314	26	27	4.6	0.16	0.24	0.19	0	1.53	1.53	4.7
	057 (reef)	21	22	4.1	0.49	0.33	0.28	-1	1.53	2.53	4
Tail-Novo		-	-	6.1	0.09	0.11	0.07	2	1.22	-0.78	6.2
Tail-Gekko		-	-	5.7	-	0.04	0.005	0.5	1.08	0.58	5.7

Results from ABA testwork on samples from the oxide zone, close to or on the sulphide boundary are presented in Table 4-3. These samples are from below the zone to be mined; however, mining is projected to terminate close to the sulphide boundary in a few locations. The data in Table 4-3 may therefore be indicative of surfaces which could be exposed by mining in certain locations. Typically, the waste samples presented in Table 4-3 contain a greater proportion of sulphide sulphur and therefore have higher AP values than materials from shallower depths. In general, these deeper materials would have a greater potential for acid generation than the majority of material to be mined, as represented by the samples in Table 4-2. As the data in Table 4-3 are for indicative purposes only, they are not included in Figures and Tables elsewhere in this memo.

Table 4-3: ABA testwork results for samples from the oxide / sulphide boundary zone

Drillhole		Depth (m)		Paste pH	EC	S	S-SO_4	ANC	AP	NAPP	NAG pH
		from	to		mS/cm	%	%	kg H_2SO_4/t			
BCRC14-	012	17	18	5.3	0.15	0.21	0.07	4	4.28	0.28	3.7
	052	19	20	4.1	0.12	0.2	0.1	-1	3.06	4.06	4.2
	065	19	20	4.9	0.21	1.06	0.12	7	28.76	21.76	2.5
	093	25	26	4.2	0.56	0.52	0.17	1	10.71	9.71	3
	155	23	24	4.7	0.23	0.61	0.06	4	16.83	12.83	2.8
	170	22	23	4.4	0.38	0.14	0.12	0	0.61	0.61	4.9
	179	29	30	4.8	0.28	0.4	0.07	4	10.10	6.10	3.1
	189	23	24	4.1	0.42	0.25	0.2	-1	1.53	2.53	4.5
	294	33	34	3.8	1.1	2	0.35	0	50.49	50.49	2.4
	336	14	15	5.2	0.14	0.11	0.1	1	0.31	-0.69	5.9

4.2.4 Material classification

Results from ABA testwork may be used to classify materials as non-acid forming (NAF) or potentially acid forming (PAF). Using NAPP and NAG pH (Figure 4-4), the majority of samples fall in the "Uncertain" quadrant where NAPP is positive (i.e. net acid forming) but NAG pH >4.5. Four waste and the sample from the reef classify as PAF, with a further five waste and one tailings sample classifying as NAF. Although samples classify as PAF, the majority would be considered as low capacity PAF (PAF-LC) as they have NAPP values <5 kg H_2SO_4/t.

Classification using ANC and AP is presented in Figure 4-5, with the majority of samples falling in the PAF zone, including the ore reef and one tailings sample. Only two waste samples classify as NAF.

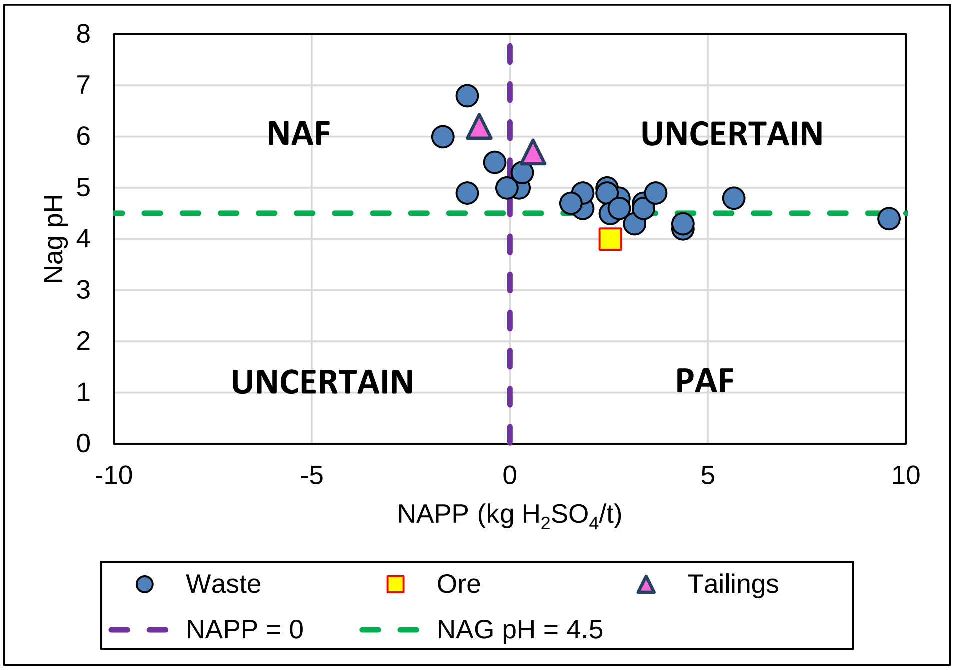


Figure 4-4: AMD classification using NAG pH and NAPP

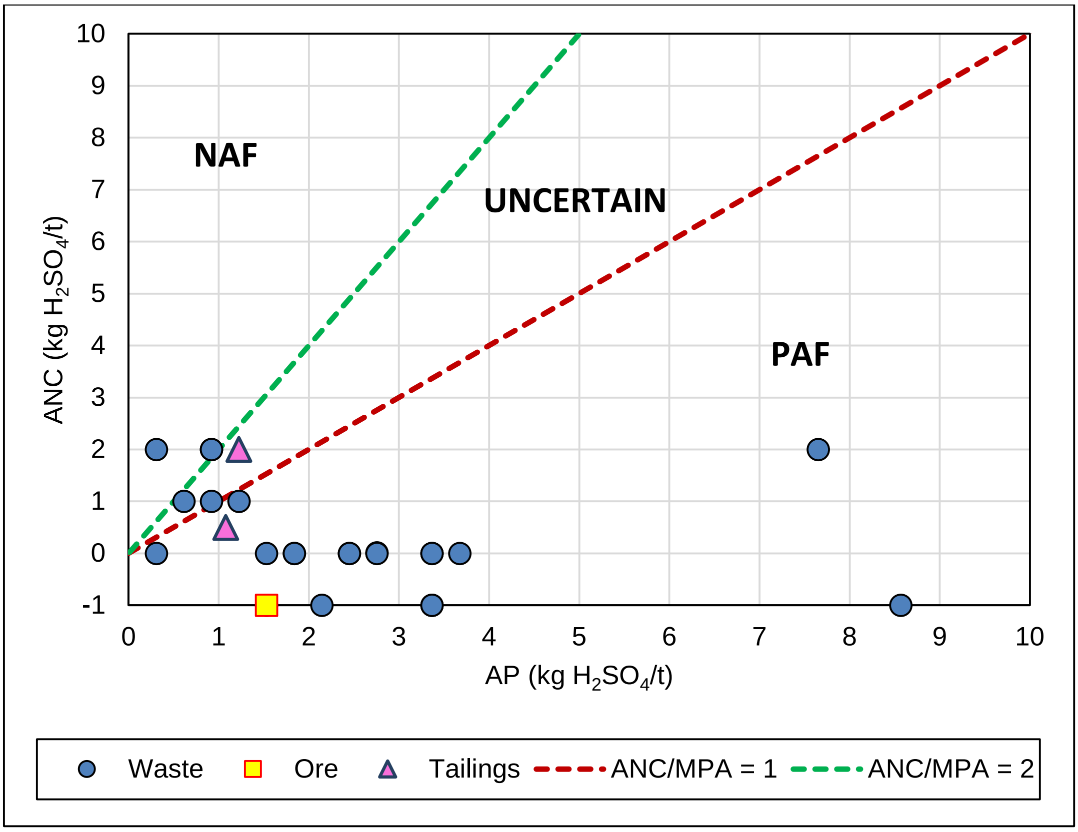


Figure 4-5: AMD classification using ANC and MPA

The large number of samples which classify as Uncertain (Figure 4-4) and as PAF (in particular in Figure 4-5) are a result of the paucity of acid neutralisation in the materials tested. Although the predicted acid generation levels are not particularly high, the absence of ANC results in uncertainty in classification.

4.2.5 Multi-element determination

Seven samples were submitted for multi-element determination and the results are presented in Table 4-5. From these results, global abundance index (GAI) values were calculated (Pendragon, 2015) and these are presented in Table 4-5 (only values of 1 or greater are presented). The GAI is a tool which provides a measure of geochemical enrichment relative to a base level, such as average crustal abundance. The GAI (based on a log-2 scale) is expressed in 7 integer increments (0 to 6). A GAI of 0 indicates that the content of the element is less than, or similar to, the average crustal abundance. A GAI of 3 corresponds to a 12-fold enrichment above the average crustal abundance and a GAI of 6 corresponds to a 96-fold, or greater, enrichment. Elements with a GAI value of 3 or more are generally considered to be "enriched". As can be seen in Table 4-5, only As (all samples), S and Sb (2 samples) recorded GAI values of 3 or greater.

Table 4-4: Multi-element results

Analyte	Unit	BCRC14-002 21-22	BCRC14-056 2-3	BCRC14-056 14-15	BCRC14-063 1-2	BCRC14-199 15-16	BCRC14-274 7-8	BCRC14-057 21-22 (Reef)
Al	mg/kg	49593	49247	49433	28574	52322	49429	50191
As	mg/kg	61	82	159	193	128	93	98
Ba	mg/kg	185	194	208	133	227	281	246
Ca	mg/kg	56	88	-	2460	58	87	-
Ce	mg/kg	36	42	34	20	35	46	38
Co	mg/kg	2	1	3	4	5	3	3
Cr	mg/kg	88	114	146	147	249	324	172
Cu	mg/kg	21	33	33	38	39	47	26
Fe	%	1.16	2.33	2.87	2.84	4.25	4.75	2.97
K	mg/kg	19690	16824	19059	10078	12652	14249	19700
La	mg/kg	-	22	-	-	21	24	23
Li	mg/kg	6	6	7	5	21	27	7
Mg	mg/kg	943	873	1143	777	3226	2846	1363
Mn	mg/kg	33	39	34	49	50	40	33
Mo	mg/kg	4	4	6	8	4	5	5
Na	mg/kg	1054	1541	890	905	1457	1416	1075
Ni	mg/kg	17	19	17	23	59	42	20
P	mg/kg	62	64	54	-	66	69	73
Pb	mg/kg	17	51	33	46	46	27	29
S	mg/kg	1883	3497	5109	3802	3167	1836	3426
Sb	mg/kg	-	-	8	7	-	-	-
Sc	mg/kg	6	7	8	6	13	11	9
Sr	mg/kg	19	23	18	25	24	26	22
Ti	mg/kg	647	528	575	573	600	635	635
V	mg/kg	40	45	57	45	93	76	64
W	mg/kg	-	-	-	-	-	-	-
Zn	mg/kg	6	12	10	14	26	27	14

Table 4-5: Global Abundance Index (GAI) values

Analyte	BCRC14-002 21-22	BCRC14-056 2-3	BCRC14-056 14-15	BCRC14-063 1-2	BCRC14-199 15-16	BCRC14-274 7-8	BCRC14-057 21-22 (Reef)
Al							
As	4	5	6	6	5	5	5
Ba							
Ca							
Ce							
Co							
Cr							
Cu							
Fe							
K							
La							
Li							
Mg							
Mn							
Mo	1	1	2	2	1	2	2
Na							
Ni							
P							
Pb		2	1	1	1	1	1
S	2	2	3	3	2	2	2
Sb			5	5			
Sc							
Sr							
Ti							
V							
W							
Zn							

Six of the samples with multi-element determinations were submitted for testing by the Australian Standard Leach Protocol (ASLP) and the results are presented in Table 4-6. Pendragon (2015) compared these values to aquatic life trigger concentrations and noted exceedences for Al, Cd, Cu, Ni and Zn. However, it should be noted that whilst the ASLP may give an indication of elements which may be released as materials weather, the reagents used and the water: rock ratios that were applied during the test differ from those that would apply under field conditions. Thus, contact water quality that could develop in a field-scale system may be better or worse than indicated by the ASLP.

Table 4-6: Australian Standard Leach Protocol (ASLP) results

Analyte	Unit	BCRC14-002 21-22	BCRC14-056 2-3	BCRC14-056 14-15	BCRC14-063 1-2	BCRC14-199 15-16	BCRC14-274 7-8	BCRC14-057 21-22 (Reef)
Al	mg/L	0.06	0.08	0.28	0.03	1.88	0.08	n.d.
As	ug/L	0.2	0.2	0.3	1.3	0.3	0.2	n.d.
Ba	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ca	mg/L	0.11	0.53	0.44	114.75	0.87	0.37	n.d.
Cd	ug/L	0.04	-	0.34	-	1.09	-	n.d.
Ce	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Co	ug/L	11.6	2.3	64	7	155.9	3.1	n.d.
Cr	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cu	mg/L	0.01	-	0.06	-	0.1	-	n.d.
Fe	mg/L	0.05	0.05	0.56	0.01	0.68	0.03	n.d.
K	mg/L	4.2	2.4	2.5	3.7	1.8	1.8	n.d.
La	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Li	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Mg	mg/L	1.78	0.23	7.74	6.13	28.41	3.45	n.d.
Mn	mg/L	0.058	0.014	0.182	0.141	0.436	0.038	n.d.
Mo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Na	mg/L	0.7	1.3	0.3	5.7	0.3	2.8	n.d.
Ni	mg/L	0.04	-	0.22	0.02	0.5	0.01	n.d.
P	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pb	ug/L	0.6	0.6	0.8	0.9	-	0.5	n.d.
SO_4	mg/L	14.55	7.74	42.33	307.2	138.1	21.09	n.d.
Sb	ug/L	0.02	-	0.11	0.34	0.03	0.01	n.d.
Sc	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sr	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ti	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
V	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
W	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Zn	mg/L	0.02	-	0.09	-	0.27	-	n.d.
pH	s.u.	4.8	4.7	4.3	5.6	4.1	5	n.d.
EC	uS/cm	45	28	118	635	324	63	n.d.
Acidity	mg $CaCO_3$/L	6.2	4.1	11.1	4.1	24.4	4.5	n.d.
Alkalinity	mg $CaCO_3$/L	2	1	-	4	-	2	n.d.

5 Conclusions

Geochemical assessment of the materials to be mined by Novo during implementation of the current plans at Beatons Creek has indicated that the waste rock contains a limited source of stored acidity, which resulted in low paste pH and negative ANC values. Materials classified over the range of NAF-Uncertain-PAF; however, even the majority of PAF classified samples would be considered as low capacity PAF (PAF-LC).

Although long-term acid generation may not be a major issue in materials to be mined at Beatons Creek, due to the low anticipated concentrations of sulphides such as pyrite, the apparent lack of readily reactive neutralising minerals such as calcite may be a concern, in particular where mining proceeds to a depth close to the boundary between the oxide and sulphide zones. In general, it appears that sulphide concentrations increase with depth, as would be expected in such settings.

If further work is to be carried out on Beatons Creek samples, more detailed investigation of sulphide speciation would be recommended to establish the nature of sulphates and possibly sulphides which may be present. The use of AP derived from "sulphide" content for material classification in the current assessment may need to be refined to incorporate at least some of the sulphur assumed to be sulphate from the testwork results currently available.

Yours faithfully

SRK Consulting (Australasia) Pty Ltd

Signed by:	**Signed by:**
Russell Staines	**Claire Linklater**
Principal Geochemist	Principal Geochemist

APPENDIX E

Mine Earth Soil and Sediment Letter Report November 2015a

Simon Pooley
Lead Technical Advisor
Novo Resources Corp.
Level 4, 673 Murray St
West Perth, WA 6005

23 November 2015

Dear Simon,

REVIEW OF EXISTING BASELINE SOIL DATA FROM THE BEATONS CREEK PROJECT

Mine Earth were commissioned by Novo Resources Corp. to undertake a review of baseline soil and sediment data collected by Pendragon Environmental Solutions (Pendragon) from the Beaton Creek Project (the Project). The purpose of this review was to:

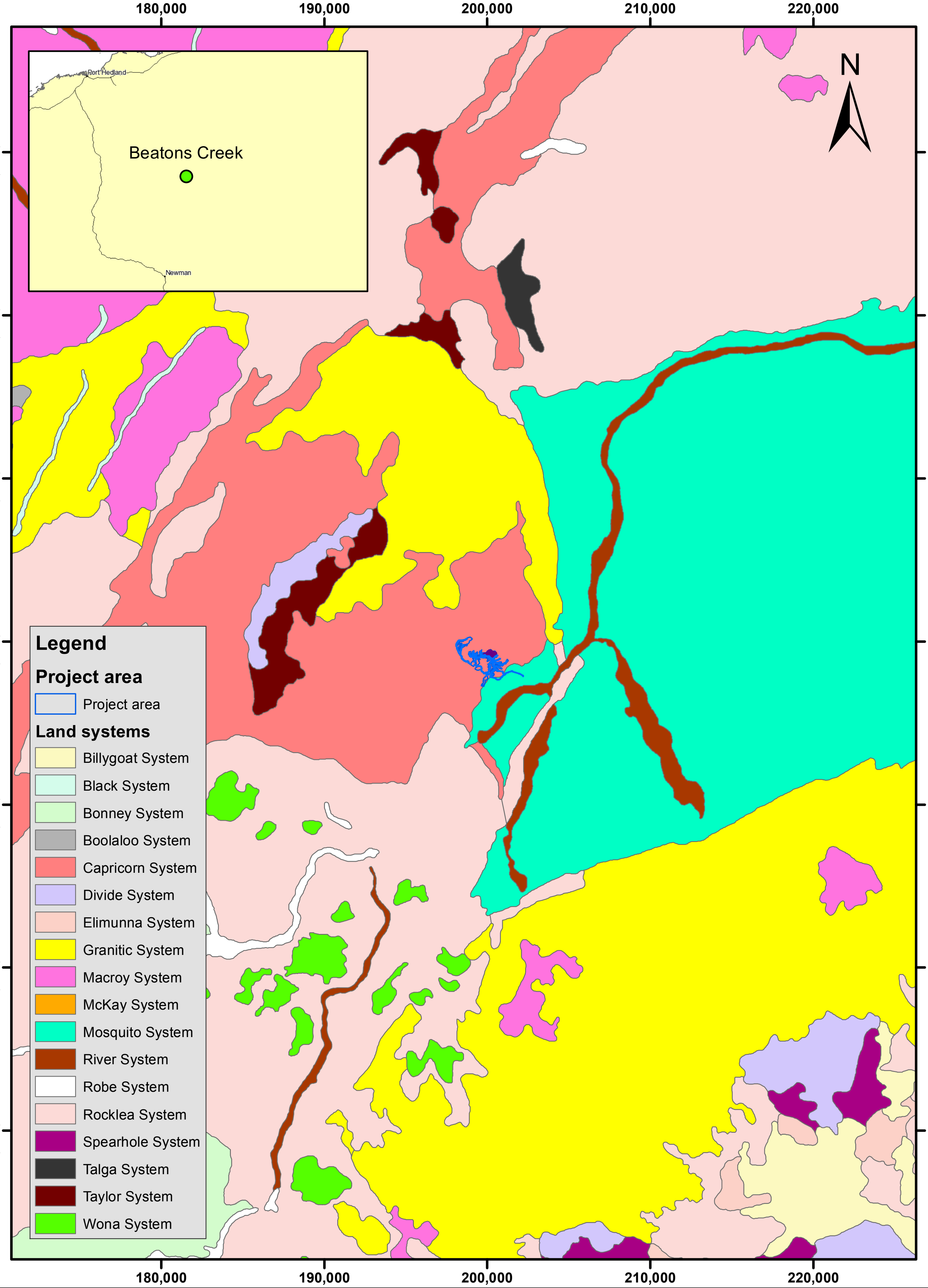
1. Develop a map of land systems within the Project area to assess differences in soil and sediment types throughout the land systems of the Project.
2. Undertake statistical analysis on baseline soil and sediment data, to assess differences in soil types throughout the Project area.
3. Prepare a topsoil inventory for Project disturbance areas, to inform rehabilitation planning.
4. Provide topsoil management and handling recommendations based on results of the baseline assessment.

The intent of this letter is to provide practical guidance in relation to the characteristics of soil types within the Project area and their applicability for use in rehabilitation activities. The data presented and discussed in this letter were sourced from the baseline assessment of soils and sediments undertaken by Pendragon (2015).

1. LAND SYSTEMS

Mine Earth completed an assessment of the land systems both regionally and within the Project area (Figure 1 and Figure 2). The purpose of this assessment was to provide context for determining whether Project topsoil could be handled as one unit or whether topsoils have different characteristics and should be stored separately. To undertake this assessment published online sources were used (Department of Agriculture and Food WA, 2015) to delineate land systems within the Project area and soil and sediment sample locations from Pendragon (2015) were overlain on the land systems map.

It was found that the majority of soil (25) and sediment (12) samples from the Project area were collected within the Capricorn land system. The Capricorn land system was characterised by ranges and hills with steep rock upper slopes. The foot slopes, lower plains and valleys of the Capricorn land system are gently sloping and stony and as are lower plans and valleys (Payne, Mitchell, & Holman, 1988). One soil sample location and six sediment sample locations occurred within the Mosquito land system. The Mosquito land system was characterised by gently undulating stony plains and prominent ridges and hills of schist and other metamorphic rocks (van Vreeswyk, Leighton, Payne, & Hennig, 2004). Soil and sediment sample locations were representative of the land systems within the Project area. In addition, proposed Project disturbance areas were also adequately represented by soil sample locations.



MINE EARTH

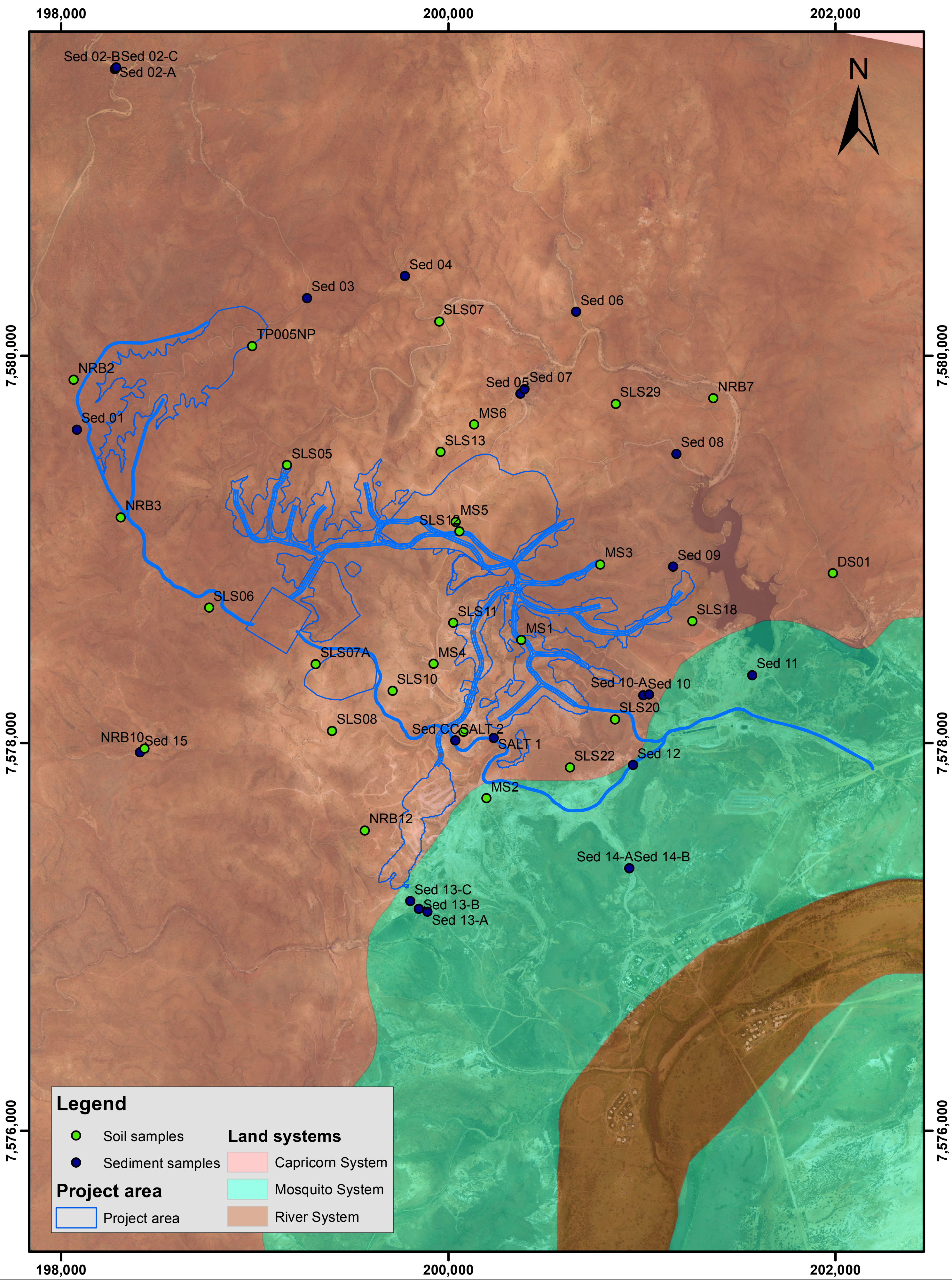
Date: 23/11/2015
Author: E Smedley

0 3 6 9 km
1:300,000 at A4

Coordinate System: WGS 1984 UTM zone 51S
Projection: Transverse Mercator
Datum: WGS 1984

Beatons Creek Soil Review
Regional land systems

Figure
1



MINE EARTH

Date: 23/11/2015
Author: E Smedley

0 0.25 0.5 0.75 km
1:25,000 at A4

Coordinate System: WGS 1984 UTM zone 51S
Projection: Transverse Mercator
Datum: WGS 1984

Beatons Creek Soil Review
Soil sample sites - land systems

Figure
2

2. SOIL AND SEDIMENT DATA

This section presents key soil and sediment results presented in Pendragon (2015). Statistical analysis of soil and sediment data was undertaken, to assess potential differences in soil types throughout the Project area.

2.1 Sediment and soil analysis

Pendragon (2015) tested soil and sediment samples for a comprehensive suite of parameters (Table 1). It is unknown whether soil or sediment samples were collected from the surface or at depth.

Table 1 Parameters assessed from soil and sediment samples (Pendragon 2015)

Sample type	Description	Soil	Sediment
Basic chemistry	pH ($CaCl_2$), electrical conductivity (EC), TSS, Moisture content	✔	✔
Exchangeable cations	Ca, Mg, K, Na, Al, cation exchange capacity (CEC)	✔	✔
Alkalinity and acidity	Total alkalinity, bicarbonate alkalinity, carbonate alkalinity, acidity	✔	✔
Total metals	Al, Sb, As, Be, Bo, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Zn, Hg	✔	✔
Nutrients and total carbon	Nitrite+nitrate, total kjeldahl nitrogen, total nitrogen, total phosphorus, total organic carbon (TOC)	✔	✔
Particle size distribution	Various screening sizes and soil classification	✔	✔
Density and porosity	Uncompacted bulk density, compacted bulk density, dry density, porosity	✔	
Atterberg limits	Liquid limits, plastic limit, plastic index, linear shrinkage	✔	
Dispersion	Dispersion percentage	✔	
Hydraulic conductivity	Field hydraulic conductivity	✔	
Jet index method and standard erosion test	Derived parameters were used as inputs for the Water Erosion Prediction Project (WEPP) model	✔	
Leachates from sediments	pH, TDS		✔
	Alkalinity – hydroxide, carbonate alkalinity, bicarbonate alkalinity, total alkalinity		✔
	Sulfate, chloride, fluoride		✔
	Major cations – Ca, Mg, Na, K		✔
	Metals – Al, As, Ba, Cd, Cr, Cu, Pb, Li, Mn, Ni, Zn, Fe		✔

Mine Earth assessed the collected laboratory data, and soil samples collected from the Project area were characterised by:

- Low pH values ranging from 4 to 5.6 and classified as extreme to strong acid.

- Low EC values ranging from 2 – 11 µS/cm and were considered to be non-saline.
- Low CEC ranging from 1.2 – 4 meq/100g. CEC values less than 6 meq/100g are considered to be very low and soils less than 3 meq/100g are often low in fertility and susceptible to soil acidification (Hazelton & Murphy, 2007).
- Low to very low concentrations of exchangeable cations (mg/kg) according the classification presented in Hazelton and Murphy (2007).
- Low concentrations of metals and metalloids such as Sb, Be, Cd, Mo, Se and Hg, which were typically below detection.
- Elevated concentrations of metals and metalloids such as Al, Cr, Co, Cu, Fe, Pb, Mn and Zn. Concentrations of these metals did not exceed relevant guideline levels. Concentrations of As at some sample locations (MS3, SLS29, SLS12. SLS11, SLS10 and SLS05) did exceed Ecological Investigation Levels (EIL) however these values are likely to be representative of the area as they were collected from relatively undisturbed locations. Concentrations of Ni also exceeded EIL levels at two sample locations (SL08 and DS01) and were also likely to be naturally occurring.
- Low plant available nitrate levels ranging between 0.2 – 9.5 mg/kg. Concentrations of Total P ranged from 53 to 356 mg/kg and was elevated but is unlikely to be available to plants (due to the low acidity and elevated concentrations of aluminium). TOC was low ranging from 0.05 to 0.37 mg/kg.
- High proportions of sands and gravels (Figure 3). However, it is likely that larger fragments were removed from the soil samples prior to analysis.
- Being likely to be non-plastic and not subject shrinkage.
- Slight to moderate dispersion, ranging from 19 to 50%.
- Erosion rates (from WEPP modelling) of 4.3 t/ha/yr and 8.7 t/ha/yr for slope heights of 10 m and 20 m (respectively). Threshold values of 5 t/ha/yr are commonly accepted.

Sediment samples collected from the Project area were characterised by:

- Low pH ranging from 3.9 to 7 which was classified as extreme acid to neutral.
- Variable EC ranging from 2 –2760 µS/cm. The higher salinity sediments were recorded downstream of the Project area in the historically impacted areas.
- Variable CEC, ranging from 13 to 7590 meq/100g. The majority of sample locations reported CEC <40 meq/100g. CEC values in excess of 40 meq/100g are considered to be very high and likely to retain major cations well (Hazelton & Murphy, 2007).
- Very high concentrations of exchangeable cations.
- Low concentrations of Sb, Be, Cd, Mo, Se and Hg, with most typically below detection.
- Elevated concentrations of Al, Cr, Co, Cu, Fe, Pb, Mn and Zn. Concentrations of these metals did not exceed relevant guideline levels. Concentrations of As in most sediment samples exceeded ANZECC sediment trigger values (ANZECC, 2000) however these values are likely to be representative of the area as they were collected from relatively undisturbed locations. Concentrations of Ni also exceeded ANZECC trigger sediment values for four samples (SED14A, SED13C, SED13A and SED11) and were also likely to be naturally occurring.
- Low plant available nitrate concentrations, ranging from 0.2 – 8.7 mg/kg. Concentrations of Total P ranged from 25 to 778 mg/kg and were elevated but unlikely to be available to plants due to the low acidity and elevated concentrations of aluminium. TOC was low ranging from below detection to 0.6 mg/kg.

- A low proportion of fines and a greater proportion of sand in comparison to soil samples (Figure 3).
- Concentrations of Cd, Cu, Pb, Mn, Ni and Zn in leachates exceeding guideline levels for 80% of aquatic species in fresh water (ANZECC, 2000). These results were recorded from both historically disturbed and undisturbed sample locations, indicating that concentrations of these metals are naturally occurring. The laboratory assessment of dissolved metals in sediments was completed on unfiltered leachates. It may be the case that the suspended sediment was still present in the leachate and was contributing to elevated metal levels in the leachate.

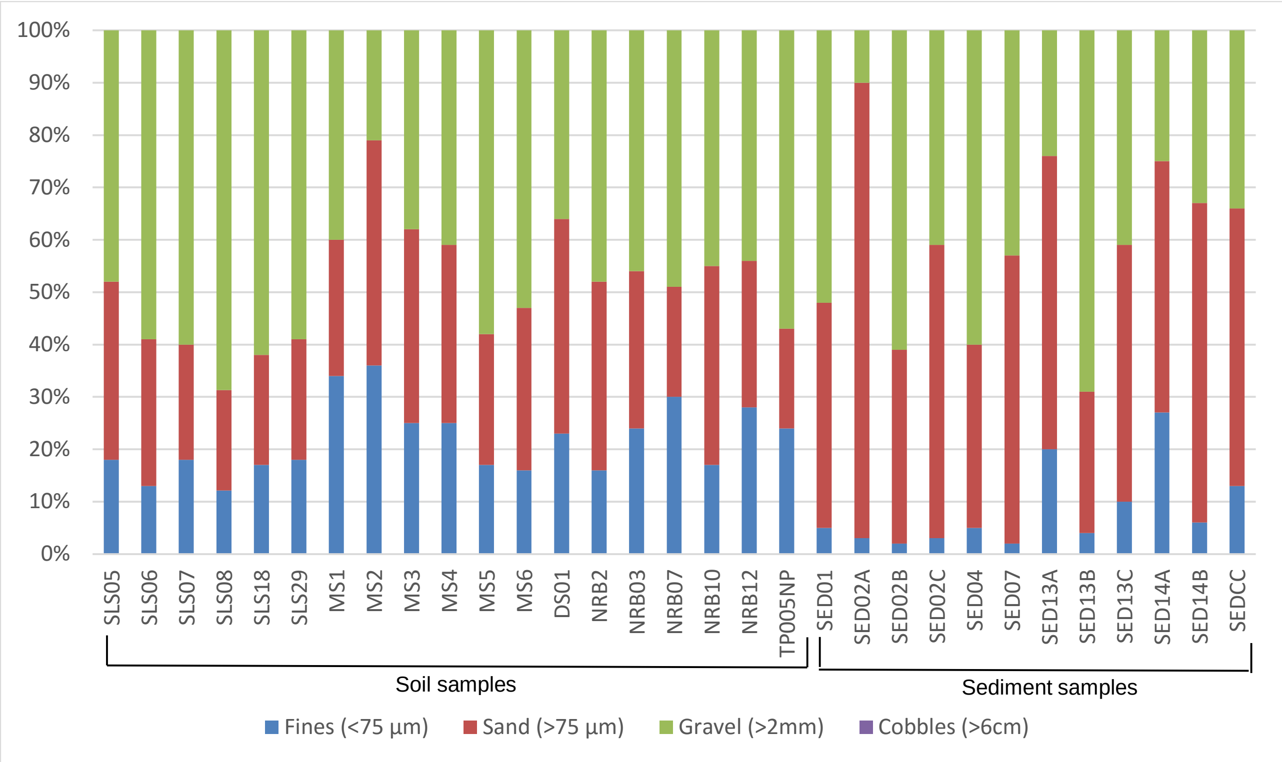


Figure 3 Particle size distribution of soils and sediments at the Project

2.2 Statistical analysis

Statistical analysis of the baseline soil and sediment data set was undertaken to ascertain potential differences between sample locations. The aim was to establish whether the Project soils could be handled and stored as one unit, or whether individual units had specific management requirements. The parameters that were assessed included basic chemistry (pH and EC), metals and nutrients. A number of parameters including major cations and some metals were excluded from the analysis, as they were typically below detection.

Statistical analysis of selected laboratory results was undertaken using Principal Components Analysis (PCA). This involved tabulating the results in Excel spreadsheets and then analysing the results using the PRIMER (Version 6) software package. Ordination of the data was performed using PCA to assess similarities between the results in terms of their location. PCA produces a plot on which sample locations with similar characteristics are located close together, while those with different characteristics are located further apart. Vectors on the plot represent the influence of the different parameters on the data set. The longer the vectors the greater the influence on the data set. The strength of the PCA results is explained in terms of percentage variation, a value that should exceed 60% over the first two axes in order to adequately represent the data set (Clarke & Gorley, 2006).

The PCA of baseline soil and sediment data showed some distinct differences between samples (Figure 4). Sediment samples were characterised by higher pH values and lower concentrations of TOC, Total-N, Pb, Fe, Al and Mn in comparison to soil samples. Concentrations of Total P and Cu were typically lower in sediment samples. Soil and sediment samples were therefore considered functionally different based upon basic chemistry, nutrients and concentrations of metals.

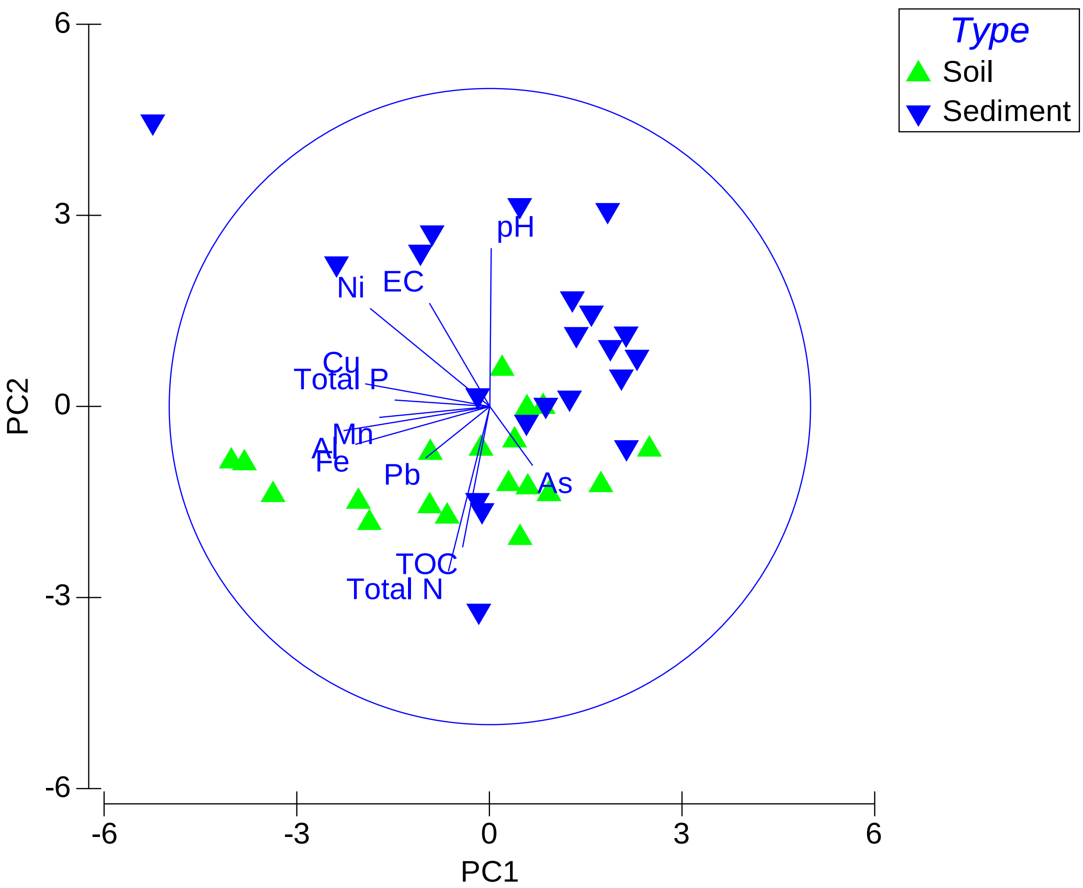


Figure 4 PCA plot of selected parameters for soil and sediment samples

A PCA of soil samples was undertaken to assess whether the soils collected across the Project area were similar in terms of their basic chemistry (Figure 5) and metal concentrations (Figure 6). Soil samples were labelled according to whether they were located in the current Project disturbance footprint. In terms of basic chemistry, nutrients and cations, soils that were likely to be disturbed by the Project were fairly similar, as shown by the tight grouping of the samples in Figure 5. The basic chemistry of disturbed soils were slightly different to other Project soils and generally had greater concentrations of TOC, TN and TOC. However, the soils were generally similar, with the exception of sample sites DS01, NRB12 and TP5NP, which were located proximal to the other sites on the plot. These sample sites were also located on the outskirts on the Project area.

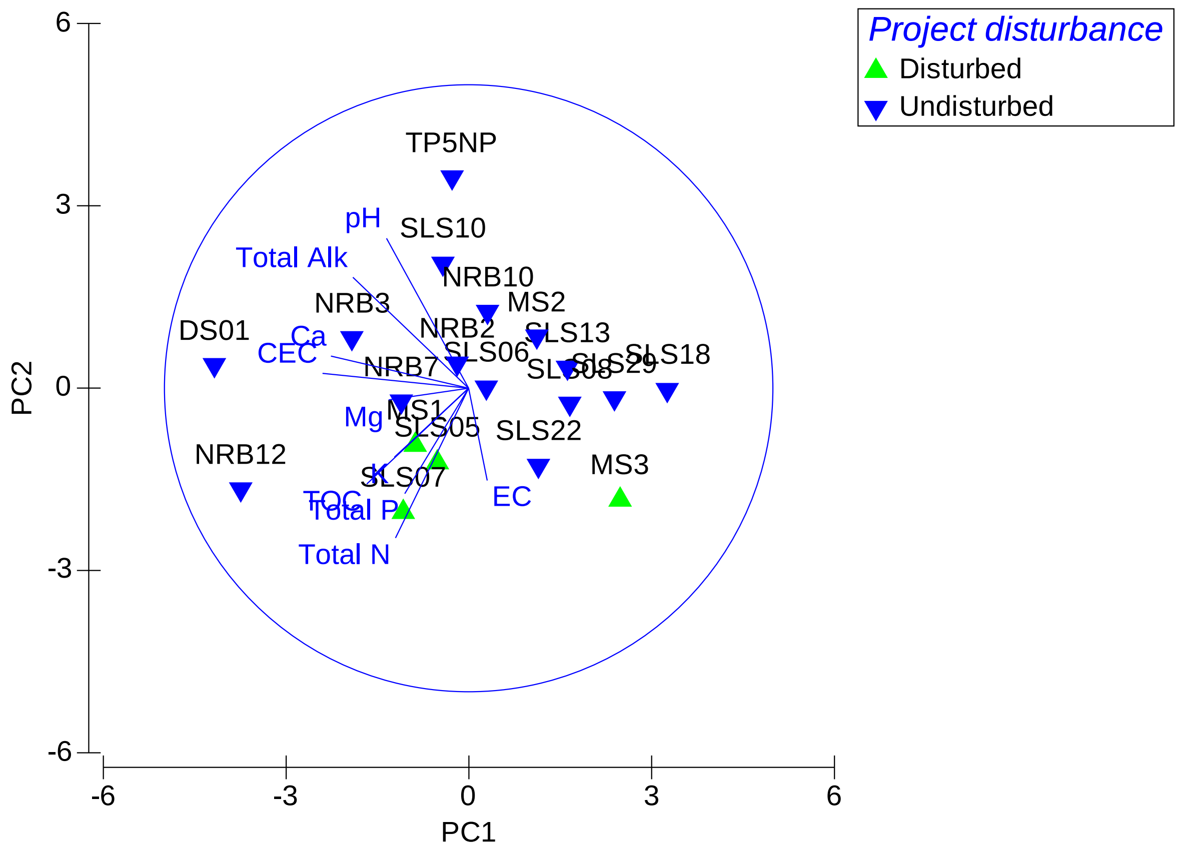


Figure 5 **PCA plot of basic parameters, cations and nutrients from soil samples according to Project disturbance**

In terms of concentrations of metals, soil samples from the Project disturbance areas also formed a tight cluster on the PCA plot indicating they had a similar chemistry (Figure 6).

Soil samples from the Project area had similar properties and therefore soil from all Project disturbance areas can be harvested and stored as one unit. As the properties of sediments differed from that of soils, if disturbed they should be harvested and stored separately from the soil stockpiles. It is likely that some small creeks (and therefore sediments) will be disturbed by the construction of the WRD. Where this is the case, from a practical handling point, these sediments should be collected and stored within the topsoil stockpile. The volume of sediments under the WRD is likely to be minimal.

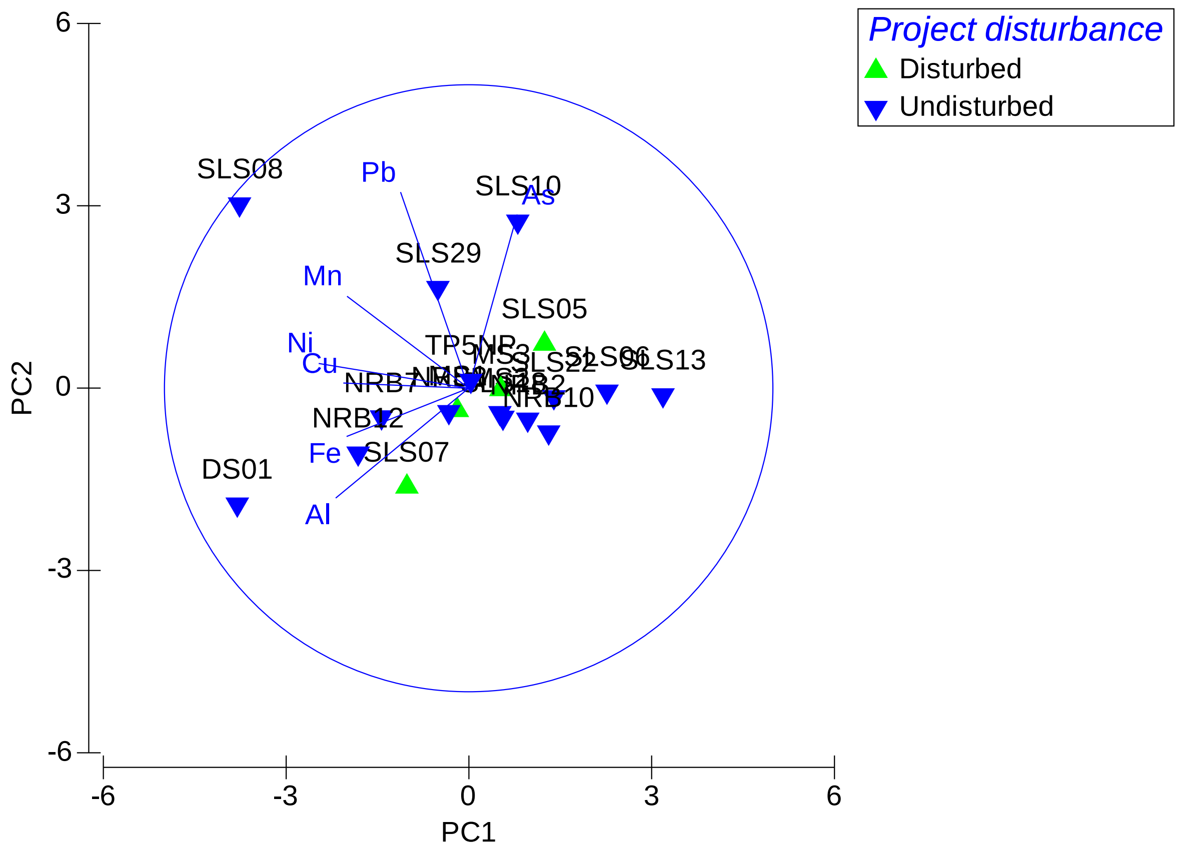


Figure 6 **PCA plot of metals in soil samples according to project disturbance**

3. SOIL INVENTORY

A soil inventory for the Project was calculated based on current projected disturbance areas and an estimate of potential topsoil recovery for the Project (Table 2 to Table 4). These calculations were based on a number of assumptions:

- Only haul road lengths were provided to Mine Earth. It was assumed these had a width of 20 m.
- All disturbance areas except waste rock dump (WRD) batters were to be topsoiled to 150mm.
- WRD batters were to be topsoiled to a depth of 160mm to account for the increased slope length.
- Topsoil can be managed as a single unit from Project disturbance areas.
- Topsoil can be recovered to a depth of 200 mm for all non-previously disturbed areas. Pendragon (2015) indicated that soil depth ranged from 200 to 400 mm throughout the Project area. It has therefore been assumed that at least 200 mm could be recovered.
- There will be no topsoil recovery from areas identified as existing disturbance (major disturbance areas as inferred from aerial photography).
- A recovery loss of 20% has been applied to account for erosion, handling losses, access restrictions and soil recovery restrictions.

Based on a soil collection depth of 200 mm and accounting for a 20% recovery loss, it was estimated that approximately 229,640m^3 will be recovered from Project disturbance areas.

It was estimated that approximately 245,121m^3 of soil will be required for rehabilitation of all Project disturbance areas. This equates to a topsoil deficit of 15,481 m^3 (Table 4).

Table 2 Estimated volume of soil that could be recovered from Project disturbance areas

Soil recovery	Value	Unit	Comment
Roads			
Length	10,100	m	Excludes where roads intersect other Project areas
Area	201,993	m^2	
Current disturbed area	27,744	m^2	
Recovered volume	*34,850*	*m^3*	
Other project areas			
Project disturbance area	141.2	ha	Entire project area (excluding roads)
Current disturbed area	15.1	ha	
Area of recovered topsoil	126.1	ha	
Recovered volume	*252,200*	*m^3*	
Subtotal	*287,050*	*m3*	
20% recovery loss	*-57,410*	*m3*	Handling, erosion, inaccessible zones
Total topsoil recovery	***229,640***	**m3**	

Table 3 Estimated soil requirements for Project rehabilitation works

Topsoil requirements	Value	Unit
Total rehabilitation area – flats	131.2	ha
Total rehabilitation area - batters	30.2	ha
Topsoil requirement – flats	196,765	m^3
Topsoil requirement – batters	48,357	m^3
Required volume	***245,121***	m^3

Table 4 Estimated topsoil balance

Topsoil balance	Value	Unit
Estimated topsoil recovery	229,640	m^3
Estimated topsoil requirements	245,121	m^3
Topsoil budget	***- 15,481***	***m^3***

4. SOIL HANDLING AND MANAGEMENT RECOMMENDATIONS

Effective soil handling and management practices are critical for revegetation success. Recommendations for harvesting, storing and managing Project soil resources are provided below

4.1 Harvesting topsoil

Topsoil should be stripped to a maximum depth of 200 mm as the native species seed bank and most of the biological activity occurs in the top 100 mm of the soil profile (Van Gorp & Erskine, 2011). Given the likely topsoil deficit, additional volumes might be harvested from areas where the soil / subsoil extends deeper than 200 mm. Deeper soil / subsoil should be stored separately from the soil and sediment stockpiles, because of likely differences in composition.

To preserve the integrity of soil as much as practicable, topsoil should only be stripped and moved during dry conditions (DMP and EPA, 2015; Golos & Dixon, 2014).

4.2 Soil storage

Direct placement of topsoil on rehabilitated areas is the most effective in terms of maximising rehabilitation success (Van Gorp & Erskine, 2011; Van Etten, McCullough, & Lund, 2012). Stockpiling of topsoil can result in increased bulk density, decreased water holding capacity, chemical changes, reduced nutrient cycling, reduced microbial activity, and loss or reduction of viable plant remnants (Ngugi, Neldner, Doley, Kusy, Moore, & Richter, 2015). The seed bank of topsoil stockpiles is also diminished by storage due to anaerobic conditions within the stockpile resulting from increased moisture and decomposing vegetation (Golos & Dixon, 2014).

The duration of soil storage can also be a factor to revegetation success. Recent studies have shown that the seed bank decline is minimal after one year, but significant after two years (i.e. a 50% decline in the seed bank viability was reported between year one and two). This is particularly apparent for grass species such as *Triodia* and *Eriachne* (Golos & Dixon, 2014). This study also reported that dry storage of topsoil can result in approximately 3.5 times larger germinable seed bank.

The MCP guidelines (DMP and EPA, 2015) recommend the following in relation to soil storage:

- Use stockpiled topsoil as soon as feasible, to reduce the time the topsoil is stored (Ngugi, Neldner, Doley, Kusy, Moore, & Richter, 2015).
- Design stockpiles that have a height greater than 2 m (to reduce the amount of moisture in the stockpile).
- Design stockpiles to optimise run-off from the stockpiles.

These recommendations may not be suitable for the Project and Mine Earth recommend the following where feasible:

- Topsoil stockpiles should be paddocked dumped or pushed up into windrows.
- Vegetation removed during clearing should be track rolled through the soil.
- Provenance native seed should be applied to topsoil stockpile.
- Soils should be stored as one unit and sediments as a separate unit (if disturbed).

4.3 Amelioration of stockpiled soil

In terms of the topsoil resource at the Project, there are a number of factors that will require management prior to its use in rehabilitation activities. The low pH of soils may impact the ability of vegetation to germinate as a pH range of 5.5 to 7.0 is typically required for germination. Stockpiling of topsoils may contribute to an increase in pH (Golos & Dixon, 2014), but acidic soils are still likely to prevail. Acidity may be managed with the addition of lime, however given that the soils are representative of natural conditions, it is likely that vegetation may have adapted to these acidic conditions. It is imperative that seed used for rehabilitation activities at the Project is sourced locally.

Given the low plant available N within the soil samples, it is likely that a high nitrogen, low phosphorus slow release fertiliser will be required to increase concentrations of plant available N in stockpiled topsoil.

It is recommended that the topsoil stockpiles are assessed to determine their pH status prior to their use for rehabilitation activities. This will allow the requirement for lime addition to be assessed. During this time, the nutrient status should also be assessed to determine the fertiliser requirements of the topsoil stored in the stockpiles.

Concentrations of Al, Fe and Mn may be potentially toxic to plants however, this will be less likely if the pH of the topsoil increases (Delhaize & Ryan, 1995). Also, given that these levels are naturally high in baseline surface soils, it is likely that plants in the region have adapted to high concentrations of these parameters.

If feasible, rehabilitation trials assessing plant growth and germination versus soil treatments (addition of lime and fertiliser) is recommended. In addition, it is recommended that Novo Resource Corp. implement a seed collection programme during operations to ensure that the provenance seed store for the Project is sufficient for rehabilitation activities. It is likely that the seed collection program will need to be implemented over numerous seasons to collect sufficient quantities of seed.

Yours sincerely

Mine Earth

……………………..…

Stacey Gregory

PRINCIPAL CONSULTANT

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APPENDIX F

Mine Earth Waste Rock Characterisation Report December 2015b

Simon Pooley
Lead Technical Advisor
Novo Resources Corp.
Level 4, 673 Murray St
West Perth, WA 6005

7 December 2015

Dear Simon,

REVIEW OF WASTE ROCK CHARACTERISATION DATA FOR THE BEATONS CREEK PROJECT

Mine Earth were commissioned to assist Novo Resources Corp. (Novo) in undertaking a review of existing baseline waste rock characterisation data collected from the Beatons Creek project (the Project).

A baseline assessment of the geochemical properties of mine waste was undertaken by Pendragon in 2015 (Pendragon 2015a). It was identified that an assessment of the physical properties of mine waste was also required to identify waste rock with potentially deleterious or beneficial physical properties to inform waste rock dump (WRD) design and rehabilitation planning. The aim of our review was to assess the likely physical properties of waste rock and develop practical recommendations for handling waste rock, to support the approvals process for the Project.

Mine Earth worked with Novo geological staff (L.Meter and P.Gough) to review available geological data and assess the likely stability properties of Project waste rock. Various data sources were used to inform the assessment including available literature, observations from geological staff, photographs of bulk sample excavations, core photographs and selected data from Pendragon (2015a and 2015b). No site visit, visual assessment of waste rock, sample collection or testwork was undertaken to support this assessment.

This brief letter presents the outcomes of our assessment under the following headings (i) background information, (ii) findings, (iii) WRD design and (iv) summary of findings and recommendations.

1. BACKGROUND

Mining at the Project will focus on three areas (i) Edwards lease, (ii) Golden Crown and (iii) Grants Hill (Figure 1). Novo anticipate that overburden and ore will be recovered from each area by dozer ripping and load and haul, such that drill and blast will not be required. In terms of the mining sequence Edwards lease will be mined first followed by Golden Crown then Grants Hill.

A large proportion of the Golden Crown area has been subjected to historical mining and most topsoil has been stripped from the area. Under the current plan, mining will be restricted to the oxide zone to a depth of approximately 20 m below ground level.

Novo propose to undertake a 30,000 t pilot mining and processing project during the first quarter of 2016. The pilot project will test ore types from three different areas and will also generate "as-mined" waste rock.

Deposit geology

Novo (2015) provides the following description of deposit geology:

The Project is located in the East Pilbara granite–greenstone terrain of the Early to Late Archaean Pilbara Craton of north-western Western Australia. Within the Project area mineralisation occurs in multiple, narrow stacked conglomeritic reef horizons, interbedded with unmineralized (barren) conglomerate sequences, with lateral extents ranging up to 2.5 km for mineralisation (Novo 2015).

The host rocks to the gold deposits occur towards the top of a >800 m thick sequence of poorly-stratified, poorly-sorted, polymictic, pebble to boulder[1] conglomerate sequence, which is restricted to an area within a few kilometres of Nullagine (Novo 2015).

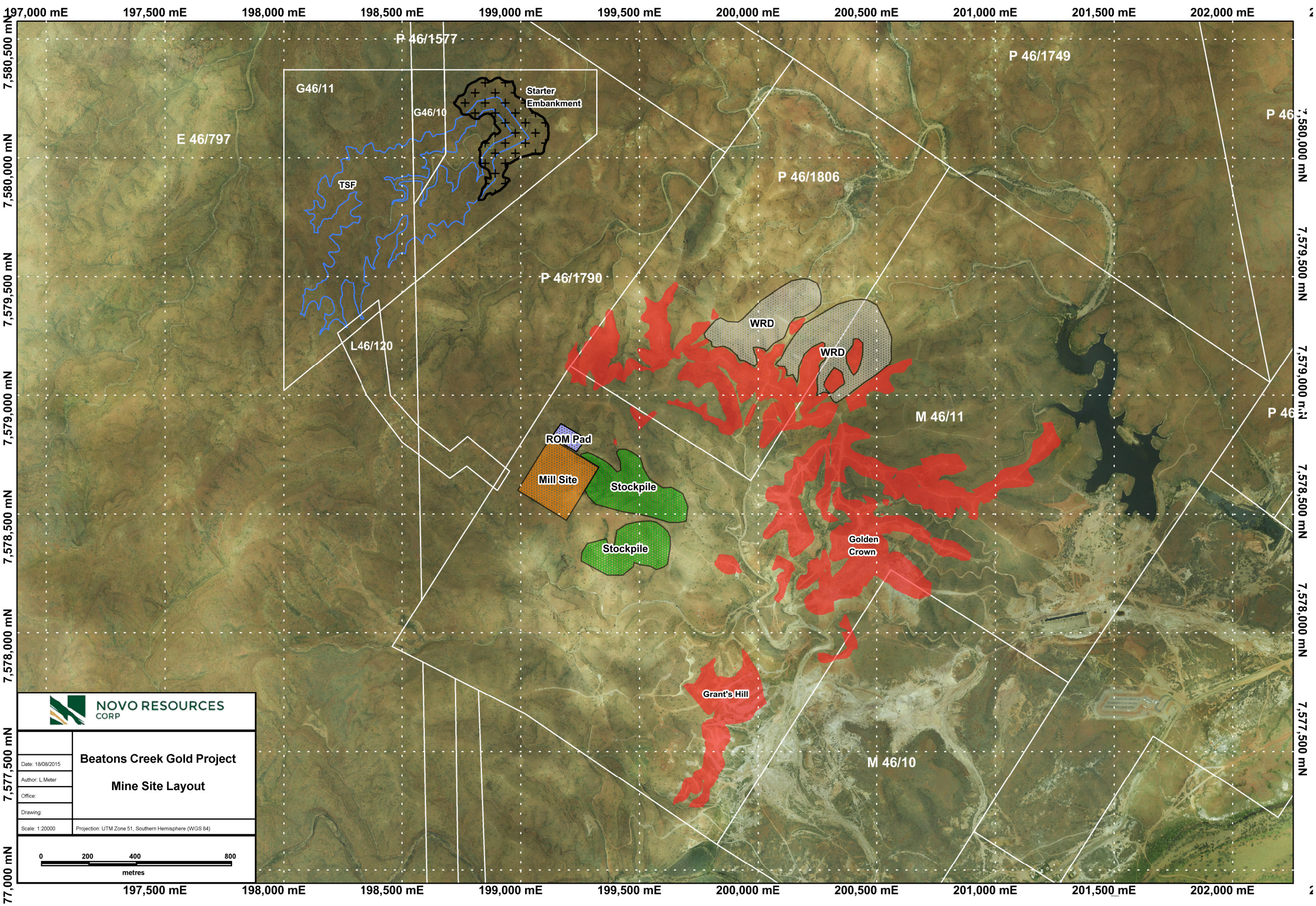
The gold-bearing conglomerates are a part of the local Beatons Creek member of the Hardy Formation, which is part of the Fortescue Group. The Beatons Creek member is up to 200m thick and is comprised of a monotonous sequence of pebble to boulder conglomerate with occasional thin interbeds of sandstone, siltstone and shale. Gold-bearing conglomerates occur within a 10-30m thick section toward the middle of the Beatons Creek member. Conglomerates occurring above and below display similar characteristics to those that are gold-bearing (Novo 2015).

Two types of conglomerates are evident and apparently interbedded with one another (i) fluvial type and (ii) armored lag type (Novo 2015).

Fluvial type conglomerate are typically clast-supported, heterolithic, pebble to cobble conglomerate with occasional boulders. Individual beds are <1 m to several meters thick and continuous over tens of meters. Clasts are dominantly sandstone, conglomerate, siltstone and shale, and clasts of various types of metamorphic rocks and granite. Sand and silt dominate the matrix (Novo 2015).

Armored lag type conglomerate are typically tightly packed, clast supported cobble to boulder conglomerate. Individual boulders can exceed 1m in diameter and comprise a heterolithic composition, but are dominated by hard, resistant, siliceous boulders of various types including vein quartz and chert (Novo 2015).

[1] Pebble to boulder or 4 to 4096 mm size fraction in accordance with the Wentworth size class (Wentworth 1922)



NOVO RESOURCES CORP
Beatons Creek Gold Project
Mine Site Layout
Date: 18/08/2015
Author: L.Meter
Office:
Drawing:
Scale: 1:20000
Projection: UTM Zone 51, Southern Hemisphere (WGS 84)
0 200 400 800
metres
P 46/1577
P 46/1749
G46/11
G46/10
Starter Embankment
E 46/797
TSF
P 46/1806
P 46/1790
L46/120
WRD
WRD
M 46/11
ROM Pad
Mill Site
Stockpile
Stockpile
Golden Crown
Grant's Hill
M 46/10
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2. FINDINGS

The likely physical properties of Project waste rock were assessed from data sources including available literature, observations from Novo geological staff, photographs of bulk sample excavations, core photographs and select results from Pendragon (2015a and 2015b).

Discussions with geological staff

Key points from discussions with Novo geological staff include:

- Mineralisation is strata-bound within an Auriferous conglomerate sub-horizontal reef.
- The waste rock consists of a conglomerate unit that overlies the ore reef. The depth of waste rock overlying the ore reef varies between 0-5 m and only oxide rock will be mined.
- The matrix of the waste rock conglomerate consists of silt and sand sized particles.
- Approximately 70% of the waste rock volume should consist of gravel[2] clasts (>2 mm) from the waste rock conglomerate. The conglomerate matrix of sand and silt[3] (>0.004 mm to <2 mm) should comprise approximately 30% by volume.
- Novo have excavated trenches through the waste rock conglomerate. Photographs from theses trenches show the anticipated coarse particle size distribution of the waste rock conglomerate (Figure 2). Photographs of gravel clasts (>2 mm) from the waste rock conglomerate are presented in Figure 3.
- The mining process for removing waste rock will involve dozer ripping prior to excavation, load and haul, and dump and doze. The proposed mining process is expected to disturb the waste rock such that the conglomerate matrix will become detached from the conglomerate clasts. It is anticipated that conglomerate clasts will remain largely intact however.
- Waste rock from the Golden Crown area is likely to be more friable and loosely consolidated than rock from the Edwards Lease and Grants Hill areas.
- Gravel clasts (>2 mm) in the waste rock conglomerate from the Golden Crown area consist primarily of metasediments and are less durable than from the Edwards Lease and Grants Hill areas.
- Gravel clasts (>2 mm) in the waste rock conglomerate from the Edwards Lease and Grants Hill areas are more silicified and durable than from the Golden Crown area.

[2] In accordance with the Wentworth size class (Wentworth 1922)
[3] In accordance with the Wentworth size class (Wentworth 1922)

Figure 2 Indicative PSD from the waste rock conglomerate

Figure 3 Example of gravel clasts (>2 mm) from the waste rock conglomerate

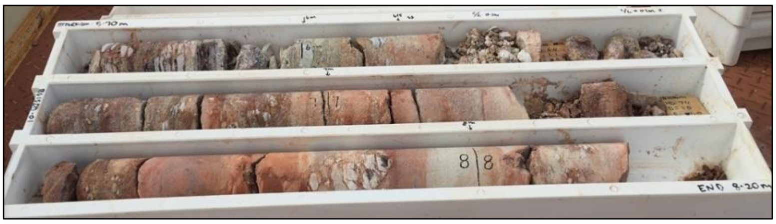
Photographs of drill core

Core photographs from two diamond drill holes DD-01 and DD-03 are presented in Figure 4 and Figure 5 respectively. DD-01 was drilled in the Edwards lease and DD-03 was drilled in the Golden Crown area. It can be seen that the core can be classified as 'very poor' in accordance with the rock-quality designation (RQD) index. RQD is an approximate measure of the degree of jointing or fracture in a rock mass and is measured as a percentage of drill core lengths ≥100 mm. From the RQD index rock mass can be classified as:

<25 %	Very poor
25-50 %	Poor
50-75 %	Fair
75-90 %	Good
90-100 %	Excellent

Tray 1 0.0-2.9 m [RQD <25%]

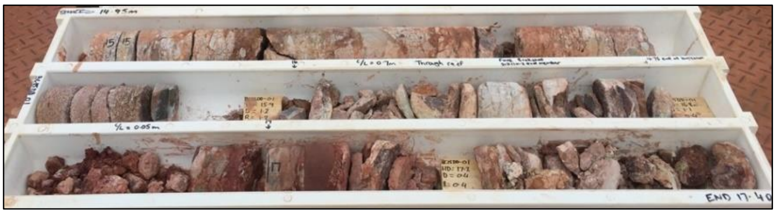
Tray 2 2.9-5.7 m [RQD <25%]



Tray 3 5.7-8.2 m [RQD <25%]

Tray 4 8.2-10.5 m [RQD <25%]

Tray 5 10.5-14.9 m [RQD <25%]



Tray 6 14.9-17.4 m [RQD <25%]

Tray 7 17.4-19.8 m [RQD <25%]

Tray 8 19.8-21.2 m EOH [RQD <25%]

Figure 4 **Core photographs from DD-01 (0.0-21.2 m) Edwards lease**

Tray 1 0.0-2.8 m [RQD <25%]

Tray 2 2.8-4.5 m [RQD <25%]

Tray 3 4.5-6.6 m [RQD <25%]

Tray 4 6.6-9.2 m [RQD <25%]

Tray 5 9.2-10.4 m EOH [RQD <25%]

Figure 5 **Core photographs from DD-03 (0.0-10.4 m) Golden Crown**

Pendragon 2015a and 2015b

A baseline assessment of Project soil resources was undertaken by Pendragon (2015b) which focussed on the surface soil to a depth of approximately 0.5 m below ground level (bgl). Whilst not directly comparable, select results from Pendragon (2015b) have been reviewed because of potential similarities between Project soils and deeper substrate rock.

Particle size distribution (PSD) from Project area soil samples were assessed by Pendragon (2015b). It was found that on average that gravel clasts (> 2mm) comprised approximately 50% of all samples. It is likely that the actual proportion of gravel in samples was higher than this because it is suspected that larger clasts (>60 mm) were excluded from the sample during collection.

Atterberg Limits from Project area soil samples were also assessed by Pendragon (2015b). Atterberg Limits establish the critical points of soil behaviour where, when increasing moisture is added to the soil fraction finer than 425 microns the soil first exhibits ‘plastic behaviour’ and ultimately with increasing moisture ‘liquid behaviour’ in accordance with the standard engineering, laboratory testing techniques. Pendragon claim that the soils were non-plastic and not subject to linear shrinkage, but the results suggest that all samples have low-plasticity.

Pendragon (2015b) commissioned flume testwork on one composite soil sample to determine the erodibility parameters required as inputs for the water erosion prediction project (WEPP) model. Pendragon (2015b) reported that the soil surface armoured quickly during simulated rainfall events and resulted in a soil surface of exposed gravels. WEPP modelling predicted that erosion rates would remain below 5 t/ha/yr for 12°, 15° and 18° slopes at lift heights of 10 m. Average erosion rates exceed 5 t/ha/yr for 15° slopes at a lift height of 20 m. 5 t/ha/yr is considered an acceptable average erosion rate for waste rock dumps.

It is unknown how representative the tested sample was of soils from the Project area. It is likely for example that larger clasts (>60 mm) were excluded from the sample during collection. For example the table (2.11) of WEPP parameters presented by Pendragon reports values of 70% sand and 15% clay were applied to the WEPP model. The table (2.1) of particle size distribution for soil samples presented by Pendragon however reports average values of 22% silt and clay, 29% sand and 49% gravel. Furthermore it is not known how the sample was prepared for flume testwork and whether the sample was subjected to repeated wetting / drying samples to replicate field conditions prior to testing.

Pendragon (2015a) assessed the mineralogical composition of samples from the oxide, transition and primary rock zones of the mineralised conglomerate reef via XRD. Pendragon (2015a) found that the mineral composition of the conglomerates was similar and consisted predominantly of quartz with lessor phyllosilicates (illite / muscovite). Clinochlores, pyrophyllite and kaolinite can be present in the near surface samples to depths of 15 m below ground level.

A description of these minerals including their hardness (Mohs) is presented in Table 1. The Mohs scale of mineral hardness is one useful indicator of rock durability. Quartz was the most abundant mineral (56-79 %wt) identified from all 29 samples (Pendragon 2015a). Quartz is a durable mineral with a Mohs hardness rating of 7 (Table 1). The next most abundant minerals were muscovite and illite (9-21 %wt) which are far less durable than quartz with a Mohs hardness rating of 1-2.5.

It is thought that Pendragon (2015a) only assessed the mineral composition of samples from the mineralised reef, so these results may not be representative of samples from the waste rock zone.

Table 1 Approximate mineral abundance and hardness from mineralised reef samples

Mineral	Group	Abundance [4]	Hardness (Mohs)	Specific gravity	Comment
Main rock forming minerals					
Quartz	Framework silicate	Dominant	7	2.6	
Muscovite / Illite	Phyllosilicates	Minor	2-2.5 / 1-2	2.8 / 2.9	Sheet silicate (both), Non-expanding clay (illite)
Hematite	Oxide	Accessory	5.5-6.5	5.3	
Potassium feldspar	Feldspar	Accessory	6-6.5	2.6	Weathering of feldspar produces clay minerals
Sodium plagioclase	Feldspar	Accessory	6-6.5	2.7	
Other minerals found in near surface samples					
Clinochlore	Phyllosilicate	Accessory	2-2.5	2.6-3.3	Sheet silicate
Pyrophyllite	Phyllosilicate	Accessory	1.5-2	2.7-2.9	Sheet silicate
Kaolinite	Phyllosilicate	Accessory	2–2.5	2.2-2.6	Sheet silicate Clay mineral Low shrink-swell capacity

3. WRD CLOSURE DESIGN

Whilst not part of the scope of this assessment, a brief review of the current WRD closure design was undertaken considering the interactions between surface stability and drainage control on the final landform and the physical properties of waste rock.

The current WRD closure design (KCB 2015) incorporates:

- Vertical lift height constrained to a maximum of 10 m
- Lifts separated by benches with a final width after reprofiling of 15 m
- Final individual batter slopes of 4H:1V or approximately 14°
- Rock armoured drop chutes to convey drainage from benches down WRD batters
- Rock armouring of WRD batters and benches
- Down stream sediment trapping

[4] Dominant (≥50%), Major (≥20%), Minor (≥10%), Accessory (≥1%), Trace (<1%).

4. SUMMARY FINDINGS AND RECOMMENDATIONS

Summary findings include:

- Two types of conglomerates occur at the Project (i) fluvial type and (ii) armoured lag type. Clasts in the armoured lag type are dominated by hard, resistant siliceous boulders compared with the fluvial type.
- The depth of waste rock overlying the ore reef varies between 0-5 m and only oxide rock will be mined.
- Approximately 70% of the waste rock volume should consist of gravel clasts (>2 mm) and the remaining 30% should comprise sand and silt from the conglomerate matrix sand and silt. Photographs taken from trenches through the waste rock conglomerate support this coarse PSD estimate.
- It is expected that the proposed mining process (dozer rip / load / haul / dump / doze) should disturb the waste rock conglomerate such that the conglomerate matrix (approximately 30% of rock volume) becomes detached from gravel clasts (approximately 70% of rock volume). It is expected however that the integrity of the gravel clasts should largely be preserved. This should have positive implications for surface stability on final WRD batters as slopes should armour overtime as gravel clasts are exposed.
- Waste rock from the Golden Crown area is likely to be more friable and loosely consolidated than rock from the Edwards Lease and Grants Hill areas. Gravel clasts (>2 mm) in the waste rock conglomerate from the Edwards Lease and Grants Hill areas are more silicified and durable than from the Golden Crown area.
- RQD values approximated from photographs of two Project diamond drill holes returned a ‘very poor’ rating in terms of degree of jointing or fracturing in the waste rock and ore rock mass. The very poor RQD rating may be attributed to the PSD within the conglomerate and the poorly cemented nature of the conglomerate clasts and matrix.
- Atterberg Limits from Project area soil samples suggest that all samples have low-plasticity.
- WEPP modelling results from one composite soil sample predicted that erosion rates would remain below 5 t/ha/yr for 12°, 15° and 18° slopes at lift heights of 10 m, but would exceed 5 t/ha/yr for 15° slopes at a lift height of 20 m. 5 t/ha/yr is considered an acceptable average erosion rate for waste rock dumps. It is unknown how representative the tested sample was of Project area soils or waste rock.
- The mineralogical composition of samples from the mineralised conglomerate consisted predominantly of quartz (56-79%wt) with lessor phyllosilicates (illite / muscovite) (9-21%wt). Quartz is a durable mineral with a Mohs hardness rating of 7 and phyllosilicates are far less durable than quartz with a Mohs hardness rating of 1-2.5. Clinochlores (Mohs 2-2.5), pyrophyllite (Mohs 1.5-2) and kaolinite (Mohs 2-2.5) can be present in the near surface samples to depths of 15 m below ground level.
- The current WRD closure design incorporates 10 m vertical lifts, 14° final slope angles, final bench widths of 15 m, rock armoured drop chutes to convey drainage from benches down WRD batters, rock armouring of batters and benches, and downstream sediment trapping

Summary recommendations include:

- All predictions regarding the physical properties and durability of waste rock should be verified during the proposed pilot mining and processing project (2016) and also continuously during the operating phase of the Project. This will include both field and laboratory assessments of waste rock durability.
- The breakdown of the waste rock conglomerate during mechanical disturbance should be assessed in further detail during the proposed pilot mining and processing project and also during the operating phase of the Project. This should include an assessment of whether the integrity of the gravel clasts is largely preserved during mechanical disturbance and whether the relative proportion of conglomerate matrix and gravel clasts is as predicted.
- Waste rock handling procedures and WRD closure designs should be progressively updated to enhance the final surface stability outcomes for the final WRD, based upon assessments of the physical properties and durability of waste rock during the pilot project and operating phase.
- Durable waste rock should be identified during mining and placed such that it is exposed on the final surfaces (especially slopes) of the WRD.
- Friable waste rock (including waste rock from the Golden Crown area) should be identified during mining and placed such that it is not exposed on the final surfaces (especially slopes) of the WRD.
- Consider an alternative closure design for the WRD to eliminate the need for drop chutes. Drop chutes require rock armour, can be difficult to construct properly, and they can fail and require ongoing maintenance after closure.

CLOSING

Please let me know if you have any queries and thank you for the opportunity to be of service.

Yours sincerely
Mine Earth

……………………..…
Shannon Mackenzie
SENIOR PRINCIPAL

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APPENDIX G

Mine Earth Waste Rock Assessment 2017

Chris Goti
Environmental Manager
Novo Resources Corp
Suite 3, 680 Murray Street
West Perth WA, 6005

13 November 2017

Dear Chris,

ASSESSMENT OF THE PHYSICAL PROPERTIES OF MINE WASTE FOR THE BEATONS CREEK PROJECT

Mine Earth was engaged by Novo Resources Corp (Novo) to complete an assessment of the physical properties of mine waste for the Beatons Creek Project (the Project). The Project is a conglomerate-hosted gold deposit located approximately 230 km south east of Port Hedland, in the Pilbara region of Western Australia.

The objectives of the assessment were to:

- Determine the physical / erosion properties of waste rock samples via desktop review and laboratory analysis.
- Determine whether stockpiled kaolinised sandstone will provide a useful low-permeability cover material.

The methods, results and findings, and conclusions from our assessment are presented herewith.

METHODS

A site visit was undertaken to the Project by Mine Earth and Novo personnel on 5 October 2017. During the visit, field observations were recorded, and four surface grab samples were collected from existing landforms. The source and purpose of each sample location is presented in Table 1.

The four grab samples were submitted for laboratory testwork as outlined in Table 2. Samples were subjected to specific laboratory testwork depending on what type of information was required. The geomechanical properties (Atterberg limits and Emerson dispersion test [EDT]) were assessed for the conglomerate waste rock samples (BCK-01, BCK-02, BCK-03) to determine their physical characteristics and susceptibility to erosion. Clay mineralogy was assessed for the kaolinised sandstone stockpile to determine the presence of shrink / swell clays.

The results from the laboratory testwork were used to derive the weathering behaviour and theoretical permeability of the samples based on their mineralogy, particle size distribution (PSD), cation exchange capacity, exchangeable sodium percentage, Atterberg limits and EDT results.

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The theoretical permeability for the samples was predicted using Hazen's formula (k=C_k d_10^2). The modified permeability coefficient (Ck) was determined from experimental data based upon the d_{10} size and the coefficient of uniformity (calculated as d_{60} / d_{10}) (Whitlow, 2001). For most samples, the PSD was sufficient to derive the d_{10} for the sample. For BCK-04, 35% of the sample passed through the finest sieve. Two permeabilities were predicted for this sample; one assuming a d_{10} of the finest sieve size and the other estimating the d_{10} based upon a log progression of the PSD.

Table 1 Source and purpose of each sample location

Sample	Source	Purpose
BCK-01	An existing, historic (~20 year old) waste rock dump (WRD) located adjacent to the Golden Crown pilot mining area.	The historic WRD is likely to be representative of waste rock to be mined from the Project. The purpose of collecting sample BCK-01 was to characterise the physical properties of the waste rock to provide a reference point for waste rock samples collected from Novo's pilot mining project (BCK-02, BCK-03).
BCK-02	Waste rock generated from Novo's recent pilot mining project (Golden Crown).	The purpose of collecting sample BCK-02 and BCK-03 was to characterise the physical properties of the waste rock and to compare these against the waste rock sample from the historic WRD (BCK-01).
BCK-03	Waste rock generated from Novo's recent pilot mining project (Golden Crown).	The purpose of collecting sample BCK-02 and BCK-03 was to characterise the physical properties of the waste rock and to compare these against the waste rock sample from the historic WRD (BCK-01).
BCK-04	A stockpile of kaolinised sandstone from a river bed adjacent to the Grant's Hill area.	The kaolinised sandstone may provide a useful source of low-permeability cover for exposures of potentially-acid forming waste rock, should it be required.

Table 2 Physical testwork

Parameters		BCK-01	BCK-02	BCK-03	BCK-04
Acidity and salinity	pH, EC	x	x	x	x
Size Fractions	Particle Size Distribution	x	x	x	x
Clay-surface chemistry	Effective cation-exchange capacity (eCEC), Exchangeable sodium percentage (ESP)	x	x	x	x
Geomechanical properties	Atterberg limits and Emerson Dispersion Test	x	x	x	
Mineralogical Composition	Clay mineralogy (XRD), Exchangeable cations				x

RESULTS AND FINDINGS

Results and findings from the field assessment and laboratory testwork are presented below.

Field Assessment

Observations from the field assessment relating to each of the sampled locations, is described as follows:

BCK-01 – Historic WRD (Figure 1)

- An historic WRD was located adjacent to Novo's pilot mining project at Golden Crown.
- The WRD was approximately 20 years old, had approximately 20m high angle of repose (+35°) slopes and demonstrated reasonable erosion stability. Some erosion features were observed on the WRD slopes because of the influence of uncontrolled drainage from the top WRD surface.
- Sample BCK-01 was collected from the crest of the WRD (Figure 3).
- Sample BCK-01 consisted of weathered rock and sandstone clasts from an Archaean conglomerate reef. The material sampled demonstrated moderate-high erosion stability, was oxidised and was strongly weathered.

Figure 1 Aerial view of the historic WRD

BCK-02 and BCK-03 – Pilot mining project (Figure 2)

- Novo recently completed a pilot mining project at Golden Crown. Waste rock was replaced into the mine void, was contoured and appeared to have been scarified.
- Waste rock was observed to be generally stable from an erosion perspective, except where uncontrolled drainage resulted in the development of erosion gullies (Figure 2).
- Samples BCK-02 and BCK-03 were collected from backfilled waste rock (Figure 3).
- Both samples consisted of weathered rock and sandstone clasts from an Archaean conglomerate reef. The material sampled demonstrated moderate-high erosion stability, was oxidised and was strongly weathered.

Figure 2 Aerial view of the recent WRD

BCK-04 – Kaolinised sandstone stockpile

- A stockpile of kaolinised sandstone was observed within a dry river bed adjacent to the Grants Hill area (Figure 3).
- Novo had earmarked the kaolinised sandstone as a potential source of low permeability cover for encapsulation of potentially-acid forming (PAF) rock, should it be required.
- BCK-04 was collected from the surface of the stockpile.
- The sample consisted of Tertiary kaolinised sandstone and exhibited low erosion stability, was oxidised and was strongly weathered.

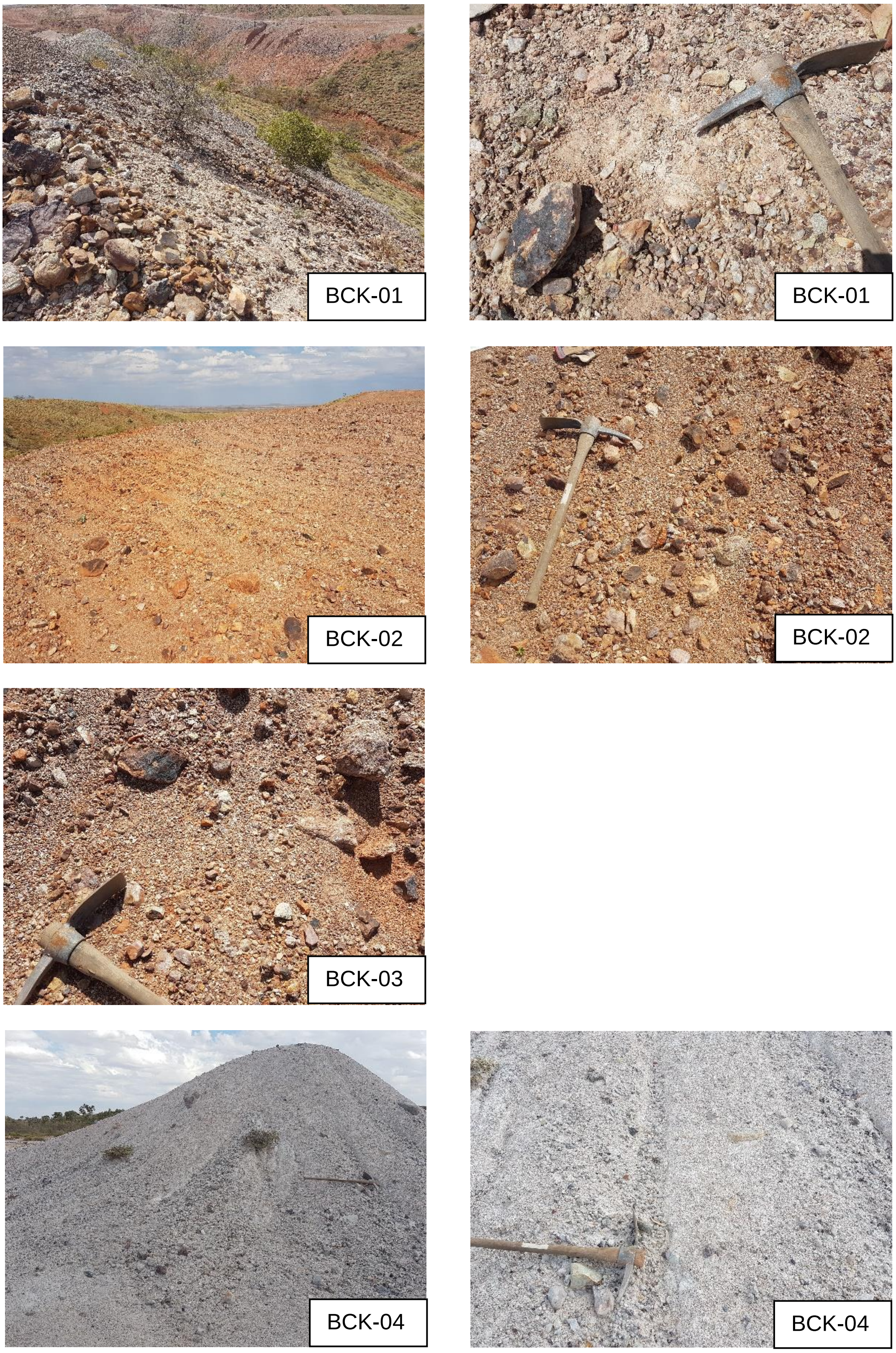

Figure 3 Sample photographs

Geological review

The erosion stability of a rock can be informed by its mineralogical composition - based on the weathering behaviour of its composite minerals.

The dominant rock type at the Project is an Archaean conglomerate containing sandstone clasts and fragments. The conglomerate contains a high proportion of quartz from the clasts. This composition, combined with the semi-consolidated nature of the conglomerate reported from the site visit, means that the conglomerate, and especially the large clasts, should be reasonably durable and should provide moderate-high erosion stability. The conglomerate matrix, depending on its exact composition, can be expected to degrade further if the binding cement is prone to dissolution.

The weathered product of the conglomerate should comprise cobbles within semi-consolidated sediment composed dominantly of quartz (due to the quartz-rich precursor), with various goethite, kaolinite and muscovite.

Laboratory testwork

From the laboratory testwork results, the following observations on the physical characteristics of the samples can be made:

- BCK-01, BCK-02 and BCK-03 all display similar particle size distributions (Figure 4 and Figure 5) defined by 70% pebbles and cobbles and approximately 15% sand particles. This correlates closely with the conglomeritic source rock. BCK-04 displays negligible cobbles and a greater proportion of silt and clay sized particles (~20%); this is reflected by its heavily weathered, kaolin-rich description.
- Samples BCK-02 and BCK-03 exhibited low salinity, BCK-01 moderate salinity and BCK-04 high salinity (Moore, 2004).
- Sample BCK-03 and BCK-02 were non-sodic, BCK-01 was marginally sodic and BCK-04 was strongly sodic. Sodic soils tend to form a surface crust, form very dense hard subsoils, and have a high susceptibility to gully and tunnel erosion (Hazelton & Murphy, 2007).
- Cation exchange capacity (eCEC) was very low (<6) in most samples except BCK-04 which was moderate (Hazelton & Murphy, 2007). A low eCEC indicates that the soil has little capacity to hold and exchange cations and as such is unable to buffer effectively against soil structural changes.
- The BCK-04 Ca/Mg ratio is very low (<1) which tends to exacerbate dispersion (Hazelton & Murphy, 2007). This should not be an issue with the kaolinised sandstone if it is intended to be buried as a cover layer over PAF rock.
- Atterberg testwork indicated that BCK-01, BCK-02 and BCK-03 all have a low plasticity index and limit, and a low liquid limit. This indicates that the material is readily mobilised by uncontrolled water flow, a result supported by gullying observed during the site visit (Figure 2).
- The EDT results placed samples BCK-01 and BCK-03 into Class 4, indicating that carbonate and gypsum are present. BCK-02 was categorised as EDT Class 6, suggesting that no carbonate or gypsum is present with the samples displaying flocculation. EDT classes 4 and 6 are considered stable, are prone to slaking but do not disperse (Moore, 2004).
- Mineralogical analysis of sample BCK-04 showed that shrink-swell clays were not present.

The PSD results were analysed to derive a theoretical permeability. Two resultant scenarios were calculated, providing the following results:

- 35% of the material passed through the 0.075mm sieve and the permeability was estimated using the d_{10} grain size.
- For Scenario 1 (conservative) a d_{10} of 0.075mm was utilised. permeability was estimated at 8.44 x 10^{-6}m/s.
- For Scenario 2 (most probable), a d_{10} of 3.87x10^{-3} mm was estimated based upon a logarithmic regression of the PSD. There was a strong logarithmic fit (r^2 = 0.96) for the grading of sample BCK-04. Permeability was estimated as 2.25 x 10^{-8} m/s.
- In comparison, the permeability of the other samples was estimated at 1.01 x 10^{-5}m/s (BCK-01), 1.8 x 10^{-4}m/s (BCK-02) and 4.05 x 10^{-5}m/s (BCK-03).
- The PSD of samples BCK-02 and BCK-03 are very similar to sample BCK-01, and generally contain coarser material (Figure 5). If sample BCK-01 is performing well on the outer slopes, the PSD would indicate that samples BCK-02 and BCK-03 could reasonably be expected to perform well too in their current state.
- If the d_{10} sizing for BCK-04 is a clay sized material as predicted through the regression curve, this would make it quite a good material for use as a low permeability cover of any PAF or erosive material.

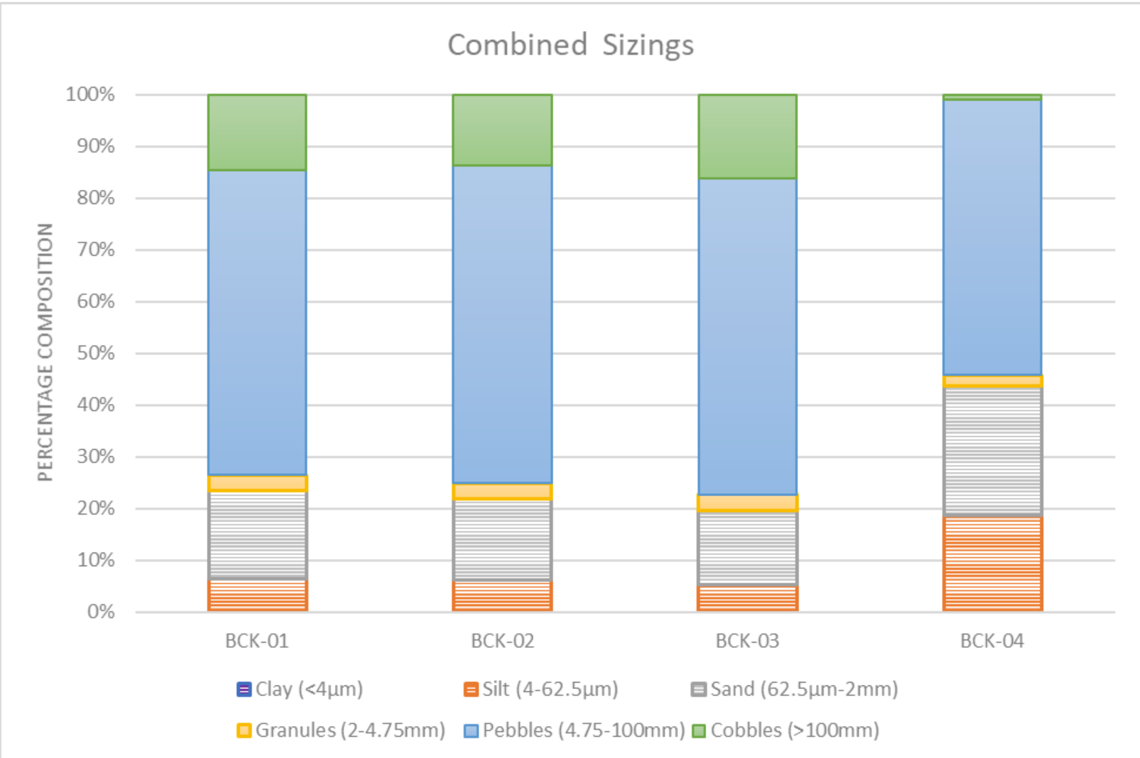

Figure 4 **Proportions of the various particle sizings of the samples from the site visit**

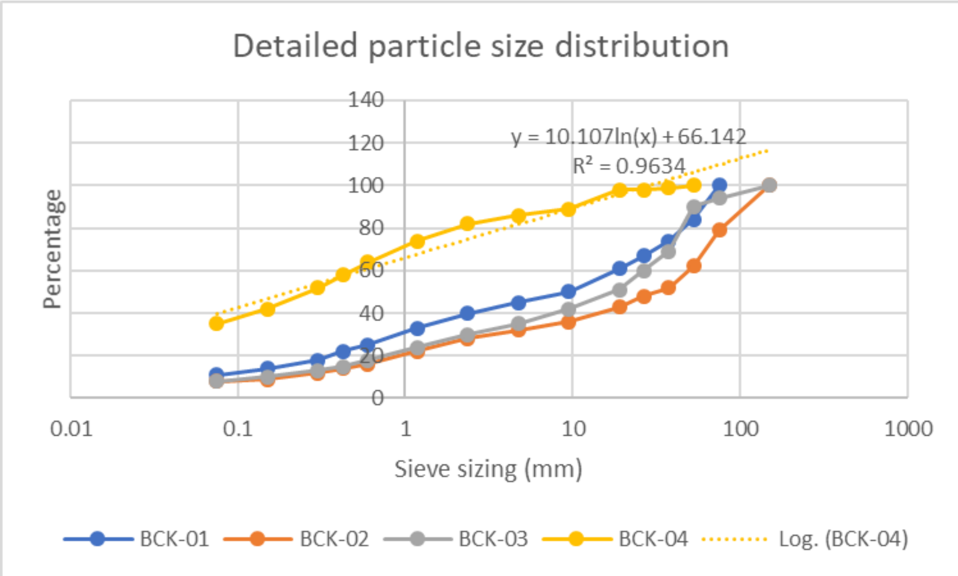

Figure 5 **Particle size distribution of samples based on laboratory testwork**

CONCLUSIONS

Conglomerate waste rock should demonstrate reasonable erosional stability.

- Whilst the slopes of the historic WRD were at the angle of repose, they demonstrated reasonable erosion stability. Erosion gullies were observed on the historic WRD slopes because of uncontrolled drainage from the top WRD surface.
- The waste rock sample from the historic WRD (BCK-01) had similar physical properties to the waste rock samples from the Golden Crown pilot mining area (BCK-02, BCK-03). This was determined from both field observations and laboratory test work. This finding indicates that conglomerate waste rock from future mining activities (assuming similar rock will be mined in the future) should behave similarly from an erosional perspective, as the historic WRD.
- The PSD of the conglomerate waste rock samples (BCK-01, BCK-02, BCK-03) indicated that they should be reasonably free-draining and should exhibit reasonable erosional stability due to their coarse/granular nature and resultant low anticipated runoff.
- In terms of pH and salinity, the conglomerate waste rock samples (BCK-01, BCK-02, BCK-03) presented no issues from a plant growth perspective.

Effective drainage control is required to minimise the potential for erosion of the conglomerate waste rock.

- Erosion gullies were observed on the historic WRD slopes because of uncontrolled drainage from the top WRD surface. Erosion gullies were observed on waste rock backfill from the pilot mining project because of uncontrolled drainage from the top surface.
- The conglomerate waste rock has a propensity to liquify and remobilise when exposed to uncontrolled drainage. This was observed from the historic WRD (BCK-01) and from the pilot mining project at Golden Crown (BCK-02, BCK-03).
- The PSD data shows a deficiency of fine (silt and clay) particles in the matrix of the conglomerate waste rock. The silt and clay fraction bind a loosely consolidated material. The lack of this fraction explains why the conglomerate waste rock is prone to liquefaction and remobilisation when exposed to uncontrolled drainage.
- The conglomerate waste rock exhibited low plasticity and low liquid limit – further evidence that this waste rock type will be prone to liquefaction and remobilisation when exposed to uncontrolled drainage.

The stockpile of kaolinized sandstone from the drainage channel near Grants Hill, should provide a useful resource of low permeability cover material to encapsulated PAF rock should it be required.

- The theoretical permeability of the kaolinized sandstone was between 1 and 3 orders of magnitude lower than the theoretical permeability predicted for the conglomerate waste rock samples.
- In terms of clay mineralogy, no evidence of shrink-swell (smectitic) clays was observed.
- Elevated salinity and sodicity were observed in the kaolinized sandstone sample, so this material might not be suitable as a final surface from a plant growth and erosion stability perspective.

The key implications for the Project from these conclusions include:

- Based upon site observations and laboratory testwork, the conglomerate waste rock should demonstrate reasonable erosional stability. This finding should be verified for run-of-mine waste rock once mining commences; flume testwork and WEPP modelling on a representative bulk waste rock sample would provide invaluable data to inform WRD design, construction and closure.
- Effective drainage control is required to minimise the potential for erosion of the conglomerate waste rock. WRD surfaces (top surfaces and berms) should be designed to effectively contain incidental rainfall from a conservative design rainfall event with adequate freeboard. It will be important to minimise the potential for drainage to overtop WRD crests and for drainage accumulation/ponding adjacent to WRD crests. Effective management of upstream drainage around the WRD perimeter will also be important.
- The kaolinized sandstone should provide a useful resource of low permeability cover material to encapsulated PAF rock, should it be required.

CLOSING

The results and findings presented in this memo are based upon a small number of samples and are contingent upon the samples that were collected being representative of their source material types overall.

Feel free to contact Mine Earth if you have any queries and thank you for the opportunity to be of service.

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APPENDIX H

Auralia Handling of Waste Material at Beatons Creek

MEMORANDUM

Attention: Chris Goti, Novo Resources Group

31 January 2018

Re: Handling of Waste Material at Beatons Creek: Grants Hill and South Hill Pits

Purpose

The purpose of this memorandum is to provide a description of the proposed handling of waste material for the Grants Hill (GH) and South Hill (SH) pits at Novo Resources Corp (Novo)'s Beatons Creek Project. Being situated in a P1 water reserve and with current mine designs expected to contain some Potentially Acid Forming (PAF) material, the handling of the PAF material to limit any adverse environmental impacts is crucial. This memorandum and the information it contains is for Novo Resource Group (Novo)'s use internally or in dealing with the DMIRS.

Background

Auralia Mining Consulting (Auralia) has been engaged by Novo to review previous technical work relating to waste handling and to assist in developing a management plan to avoid adversely impacting the P1 water reserve on which the mining operations sit. Auralia were tasked with completing pit and waste dump designs (including backfilling of pits), generating plans and cross sections of proposed designs and determining a mining sequence to limit exposure of PAF material to the environment.

Pit Inventory

All calculations relating to this work were based on pits designed to include Indicated and Inferred Mineral Resources, these designs were completed in November 2016.

Two block model reports were run for both the GH and SH pits. The "base case" report for each pit calculated the volume of blocks in the pit design that sit below the provided sulphide topography (sulphidetop.dtm), the second reported a "conservative" value, whereby the sulphide topography was raised by 2m to account for any potential variation between the actual and expected oxide/sulphide boundary. All volumes shown in Table 1 are in-situ bcm.

Table 1 Pit Inventory

Pit	Total Waste Volume	PAF Volume (base case)	NAF Volume (base case)	PAF Volume (conservative)	NAF Volume (conservative)
Grants Hill Nth	369,338	1,138	368,200	9,813	359,525
Grants Hill Sth	99,675	150	99,525	963	98,712
Grants Hill Total	469,013	1,288	467,725	10,776	458,237
South Hill	142,788	600	142,188	5,688	137,100
Total	611,801	1,888	609,913	16,464	595,337

Cross sections at 10m spacing were created for the GH and SH pits, the sections are available as separate documents (gh_sections.pdf and sh_sections.pdf). In most sections the pit does not intersect the sulphide topography, Figure 1, Figure

2 and Figure 3 show cross sections through GH South, GH North and SH respectively where the pit design has intersected the sulphide topography.

Each cross section displays the original topography (brown line), pit design (blue line) and oxide/sulphide boundary (red line) along with the oxide ore (dark blue blocks) and sulphide ore (light blue blocks).

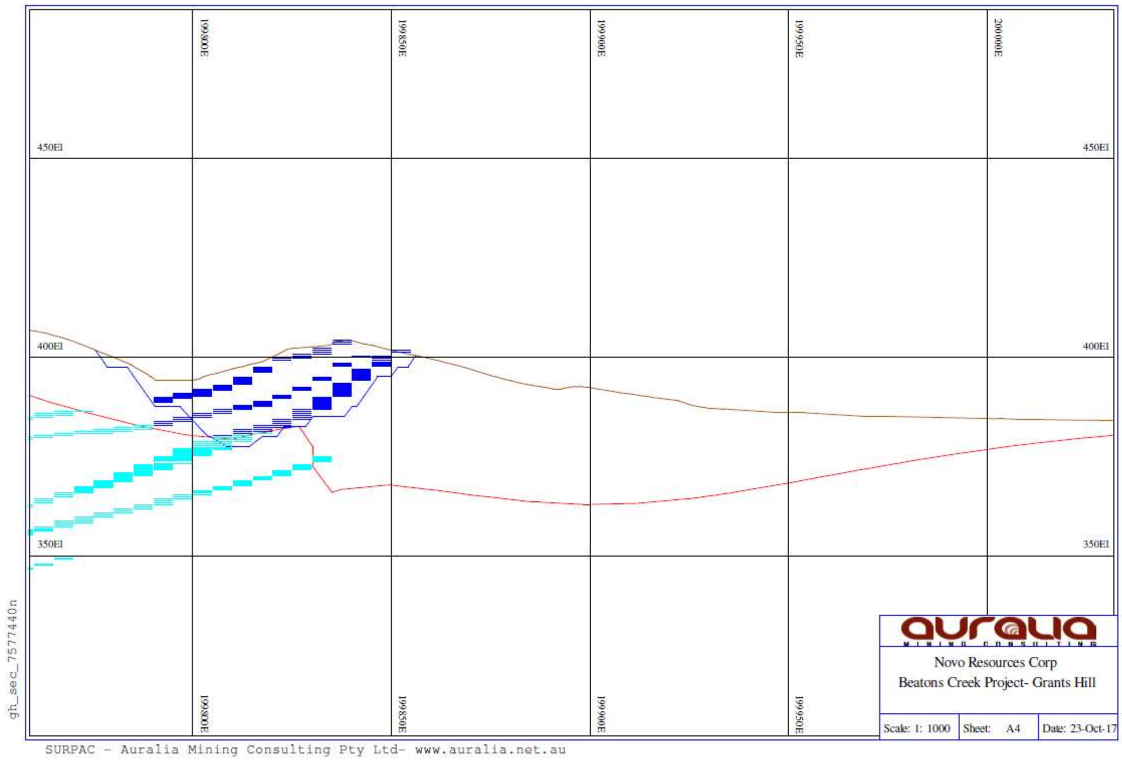

Figure 1 Grants Hill South Cross Section- 7,577,440N

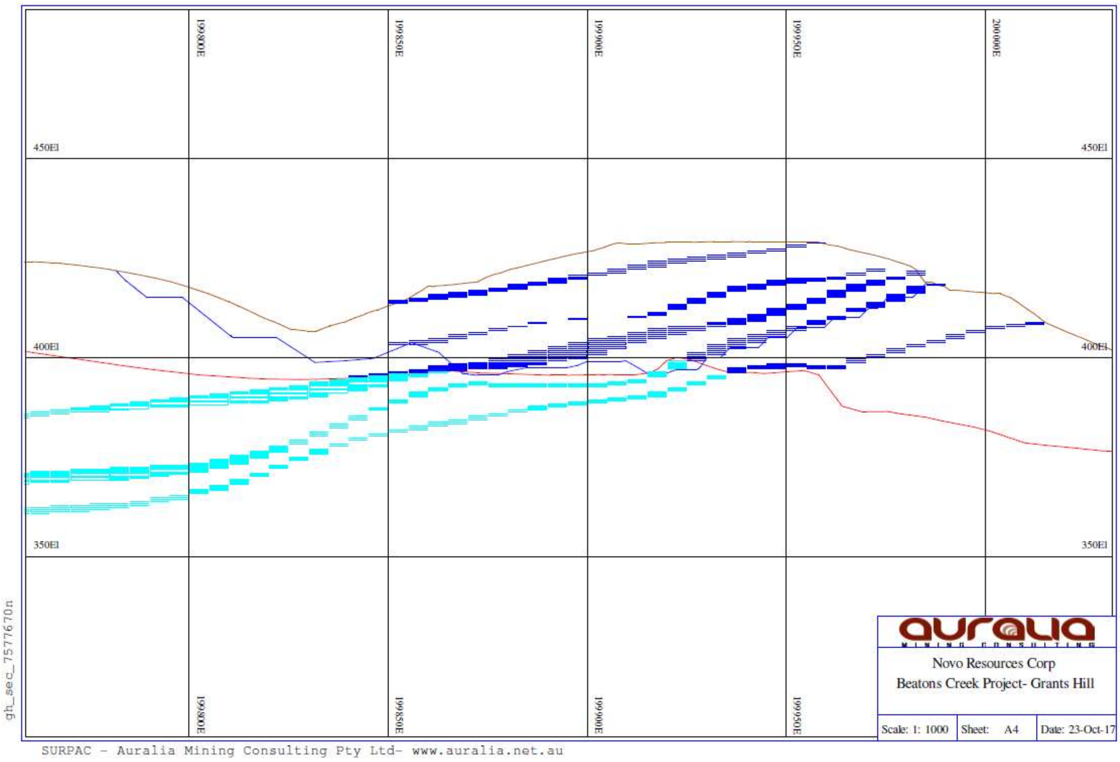

Figure 2 Grants Hill North Cross Section- 7,577,670N

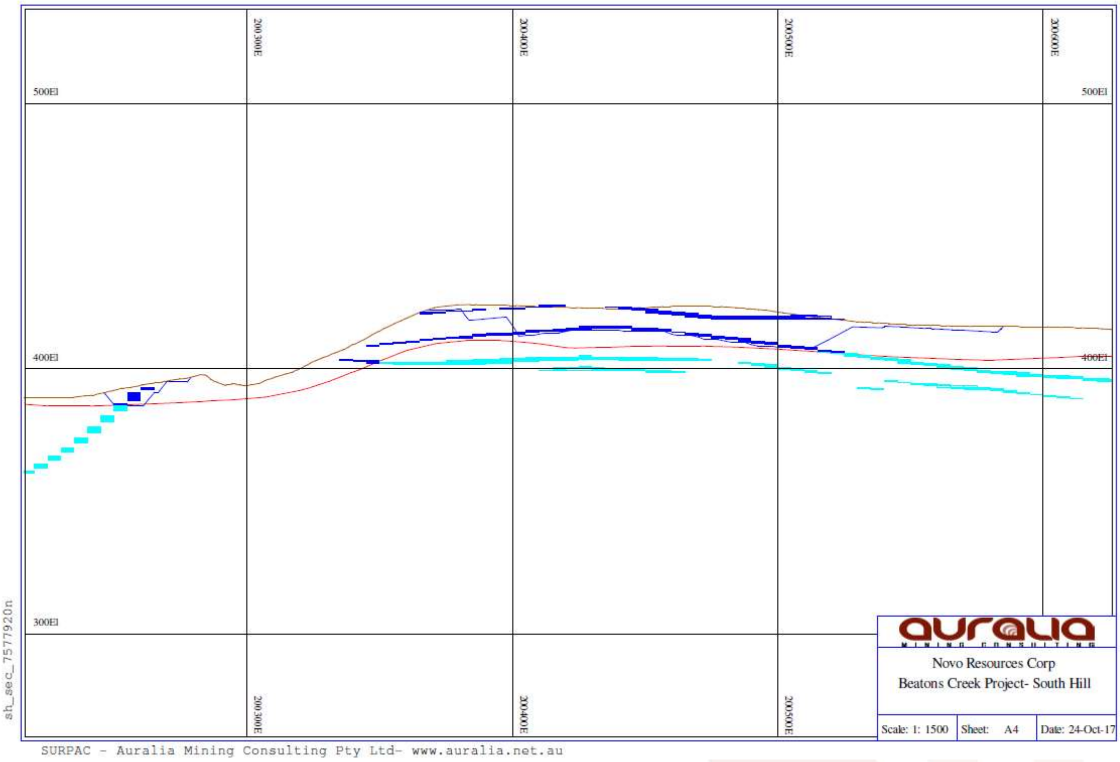

Figure 3 South Hill Cross Section- 7,577,920N

Waste Dumps and Material Movement Sequence

Waste will be contained in three locations for the GH/SH mining area:

- Grants Hill Waste Rock Dump (WRD),
- Backfilling the GH South Pit, and
- Backfilling the GH North Pit.

All PAF waste material mined from GH and SH will ultimately be stored in the GH South pit. The proposed mining sequence is to mine GH South first to allow the construction of the PAF cell, followed by mining GH North and SH.

NAF waste from the GH South pit will be trucked to the WRD positioned to the south east of the pit. Only a small amount of PAF waste is expected to be produced from this pit. A small area outside of the pit crest will be used for a short period before the PAF cell within the GH South pit is available for backfilling.

NAF waste from GH North will initially be trucked to backfill the base of GH South up to the 390mRL in preparation for the PAF cell(s), subsequent waste will be trucked to the GH WRD or to further backfill GH South as allowed. Backfilling of GH South should be at the 390mRL prior to any PAF waste being mined, the PAF waste will be trucked to the PAF cell in GH South.

NAF waste from SH will be trucked to GH North to overlay any exposed sulphide material with NAF. PAF waste will be trucked to the GH South PAF cell.

Waste from the WRD will be rehandled back to the GH North and South pits to ensure there is sufficient NAF waste covering the PAF cell.

During the waste movement process outlined above, NAF waste will be used to fill the base of the GH South pit up to the 390mRL, PAF waste will sit above, with kaolinized clays from within Novo's leases used to progressively cap the PAF waste before a minimum of 5m of NAF waste is overlain. Figure 4 shows the typical cross section of the final backfilled pit- this cross section assumes complete backfilling of the GH pits. The top of the PAF cell has a convex, dome-shaped ceiling to facilitate water shedding.

Waste from future mining areas will be used to fill the South Hill pit.

Two PAF Cells have been designed to contain the PAF material mined under the "conservative" scenario mentioned previously. The South PAF Cell is designed to contain approximately twice the volume of PAF material from the base case scenario and is expected to be the only PAF Cell required for this project.

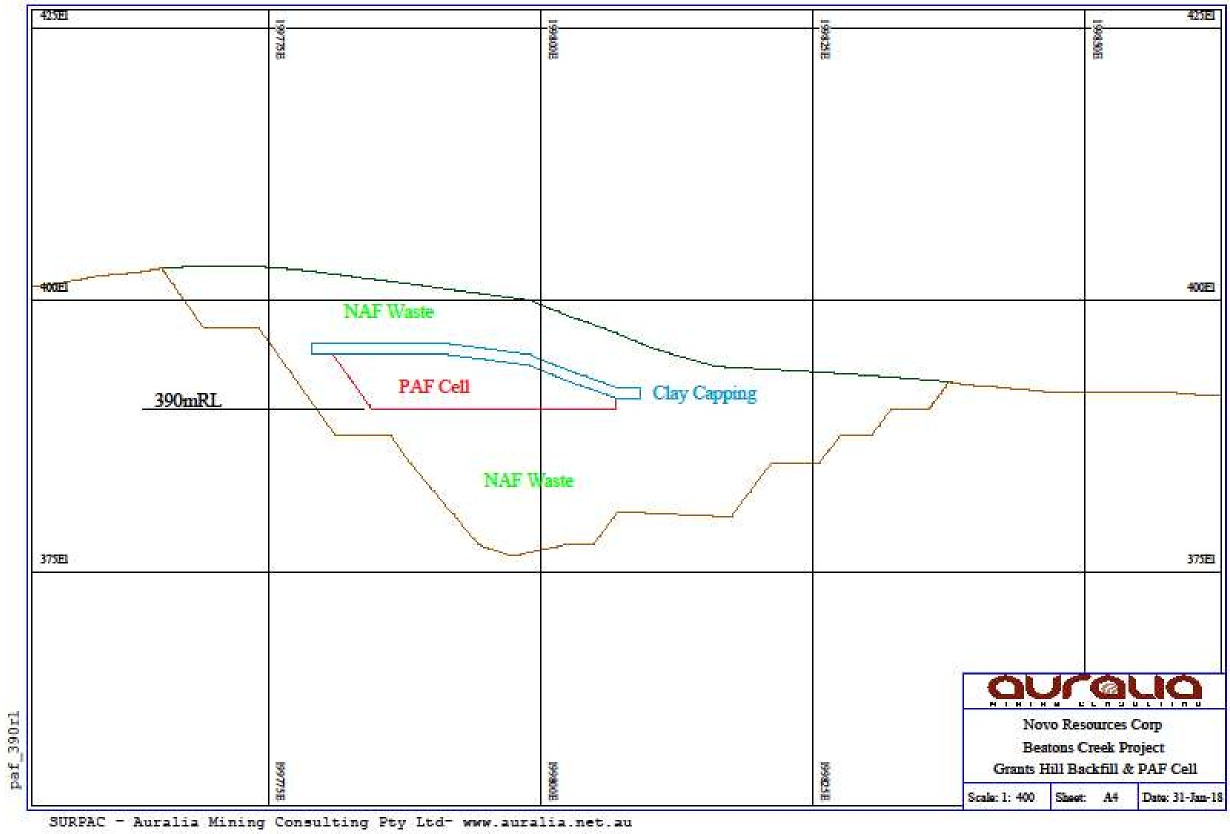

Figure 4 Typical Backfilled Pit Cross Section (South PAF Cell)

Assuming complete backfilling of the GH pits, the final topography is shown in Figure 5. Key features of this design are:

- Current Design Capacity (subject to change as per requirements):

NAF Waste (lower barrier and upper cover)	557,968m^3
South PAF Cell	4,225m^3
North PAF Cell	11,476m^3
South Clay Capping	1,807m^3
North Clay Capping	2,140m^3

- Drainage channels constructed over the GH South backfill to:
  - maintain a 5m buffer of NAF waste over the clay capping of the PAF cell, and
  - ensure most water sheds off the backfill and does not infiltrate into the PAF waste.
- Two sediment traps have been positioned downstream of the pit/backfill in the two valleys that traverse the GH North pit. These should limit any larger rocks and small sediments reaching the major water channels.
- A large area on the GH North pit has been designed as non-shedding.
- Final Grants Hill WRD would have a significantly reduced footprint.
- There would be no need for abandonment bunds around the GH pit.
- The exact contouring of the final landform can be altered to suit equipment operability and geotechnical and environmental requirements.

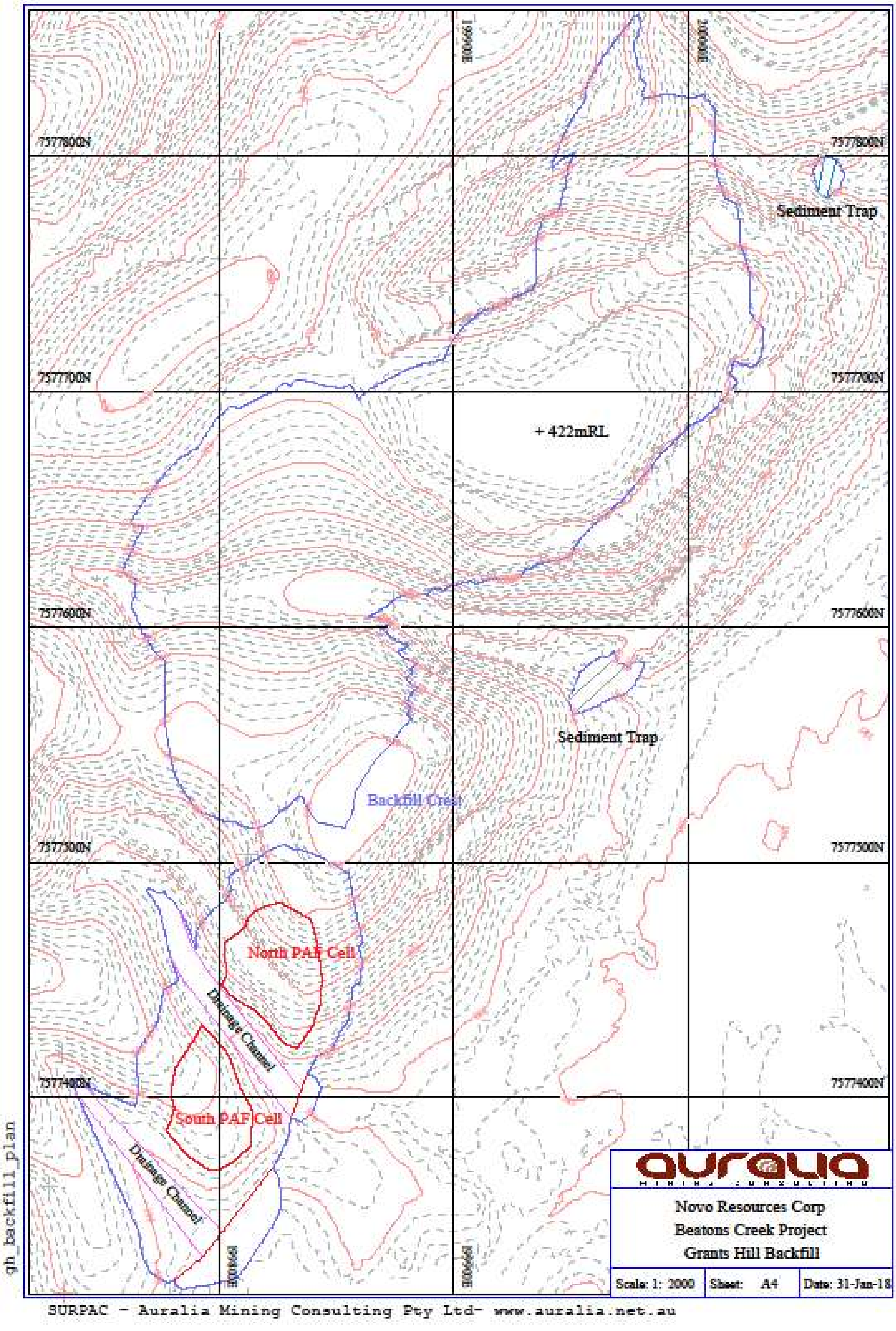

Figure 5 Plan View of Grants Hill Backfill Final Landform

Figure 6 shows a schematic of the proposed waste movement.

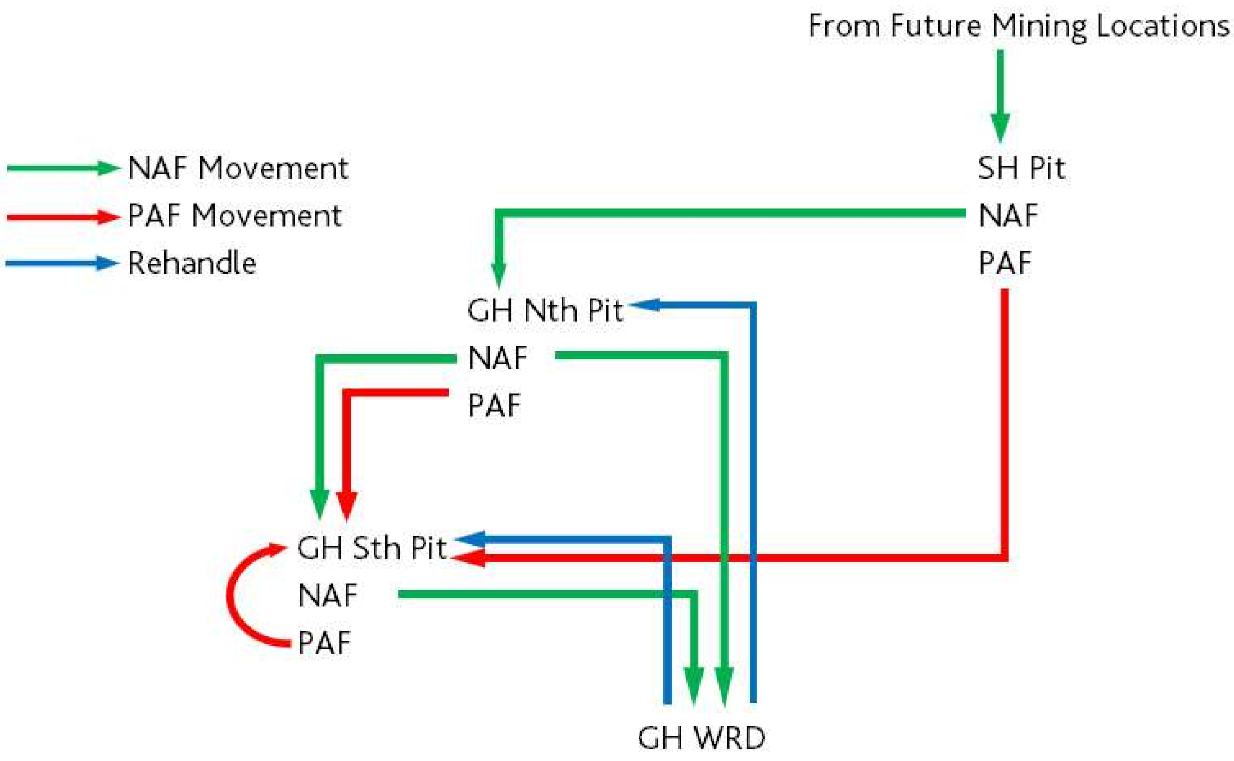

Figure 6 Schematic Diagram of Waste Movement

Regards,

Anthony Keers

Director

Auralia Mining Consulting Pty Ltd

Disclaimer

Auralia Mining Consulting (Auralia) has prepared this memorandum for the sole use of the Client (Novo Resources Corp) and for the intended purposes as agreed upon between the two parties. The memorandum may not be released to any other party without the consent of Auralia.

The design work detailed in this memorandum has been completed using data supplied by Novo. It assumes prior correctness in the supplied data for the purposes of completing the work. Any recommendations, opinions, comments or findings stated in this memorandum are therefore based upon provided data, circumstances and assumptions as they existed at the time of completing this work. Any changes to the data, circumstances or assumptions may affect any of the recommendations, opinions, comments or findings stated in this memorandum.

Any recommendations, opinions, comments or findings in this memorandum made are those of the author and may not represent the general beliefs of Auralia or the Client.

APPENDIX I

SRK H2 Hydrogeological Assessment 2018

H2 Hydrogeological Assessment Beatons Creek Gold Project

Report Prepared for

Novo Resources Corporation

Report Prepared by

SRK Consulting (Australasia) Pty Ltd

NOV005

August 2018

H2 Hydrogeological Assessment Beatons Creek Gold Project

Novo Resources Corporation

SRK Consulting (Australasia) Pty Ltd

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Executive Summary

SRK Consulting (Australasia) Pty Ltd (SRK) was requested by Novo Resources Corporation (Novo) to undertake an H2 level of hydrogeological assessment for the proposed Beatons Creek Project near Nullagine in the Pilbara of Western Australia. Proposed mining at the project does not include processing of ore, which is to be completed off site.

The project area is currently within designated Priority 1 (P1) and Priority 3 (P3) Drinking Water Source Protection Areas. Novo was required to complete a hydrogeological investigation to demonstrate that the proposed mining activities will not degrade the water supply within the P1 and to assist with managing the risk of pollution for the P3 source protection areas for the Nullagine drinking water supply.

Groundwater resources in the project areas are located within three (3) aquifers, the Mosquito Creek Formation Aquifer (MCFA), the Hardey Formation Aquifer (HFA) and the alluvial aquifer system. Drinking water is supplied from bore 6/92 and bore 7/92, located approximately 8 km northeast of the settlement of Nullagine and exploiting the MCFA.

To assess the proposal, numerous hydrogeological investigations have been completed on site, including the following:

- A permeability testing program (slug tests) completed by Novo in 2014 on existing geological resource bore holes
- Hydrogeological baseline, monitoring and production bore drilling completed by Pendragon Environmental Solutions Pty Ltd (Pendragon) in 2015
- Water quality sampling and analysis, including stable isotope analysis, completed by Pendragon in 2015
- Waste rock geochemical characterisation memorandum completed by SRK (2015, 2018)
- Pumping test program completed by Novo and interpreted by Klohn Crippen Berger (KCB)
- Water levels collected by Novo and KCB for 2015
- Time of travel calculations for groundwater flow in the MCFA
- Hydrogeological exploration for water supplies (KCB, 2015 – Appendix A).

In addition to the previously completed studies, SRK has completed a number of additional studies, including the following:

- Monthly sampling of monitoring bores in the Project vicinity for the period November 2017 to present
- Drilling programs to establish additional monitoring bores near proposed potentially acid forming (PAF) encapsulation cells
- Additional drilling and resampling/ analysis as part of an expanded lithogeochemical characterisation program.

The available hydrogeological data support a conclusion that there is a negligible risk of impacts on the Nullagine drinking water supply bores from the proposed mining activities, for the following reasons:

- The waste material has limited sources of acidity and low PAF.
- Conceptualisation of the hydrogeological system (including groundwater levels, groundwater quality and hydraulic data) supports a conclusion that there is no hydrogeological connection between the Nullagine drinking water supply bores and the location of proposed mining activities.

Additionally, no impacts on groundwater dependent ecosystems (GDEs) or stygofauna are anticipated from the proposed mining activities.

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Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (Australasia) Pty Ltd (SRK) by Novo Resources Corporation (Novo). The opinions in this Report are provided in response to a specific request from Novo to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this Report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction and Scope of Report

1.1 Introduction

SRK Consulting (Australasia) Pty Ltd (SRK) was requested by Novo Resources Corporation (Novo) to undertake an H2 level of hydrogeological assessment to meet the requirements of Operational Policy No. 5.12 – hydrogeological reporting associated with a groundwater well licence (Department of Water, 2009) for the proposed Beatons Creek Project near Nullagine in the Pilbara of Western Australia.

H2 level assessments require a basic field hydrogeological assessment, including drilling and test pumping in order to characterise the groundwater regime and to evaluate the potential for impacts on surrounding groundwater and surface water users and ecosystems.

1.2 Scope of report

The scope of work for this study includes the following:

- Collation and summary of the groundwater studies completed to date on the project
- Conceptualisation of the groundwater system
- Development of preliminary water requirements for the project site
- Identification of water supply for the project
- Evaluation of the potential for impacts on surrounding water users and ecosystems.

No additional water abstraction is being requested on the Beatons Creek project site as part of the Mining Proposal; however, the site is located within the Nullagine Drinking Water Supply Water Reserve. The specific goal of this study, therefore, is to determine what potential impacts the proposed mine activities may have on the Nullagine drinking water supply bores.

2 Background

2.1 Beatons Creek Gold Project Description

Novo is developing a Mining Proposal for the Beatons Creek Gold Project (the Project) located near the locality of Nullagine in the Shire of East Pilbara, Western Australia (Figure 2-1). Proposed mining at the project will include mining of approximately 3.10 Mtpa of oxide ore with all processing to be completed off site under a toll treatment agreement.

Gold is found within the matrix of a number of flat-lying conglomerate reefs which are up to 2 m thick and are laterally extensive. Geomorphology of the area includes prominent ridges up to 30 m high separated by incised valleys. The gold-bearing reefs outcrop within the walls of these ridges.

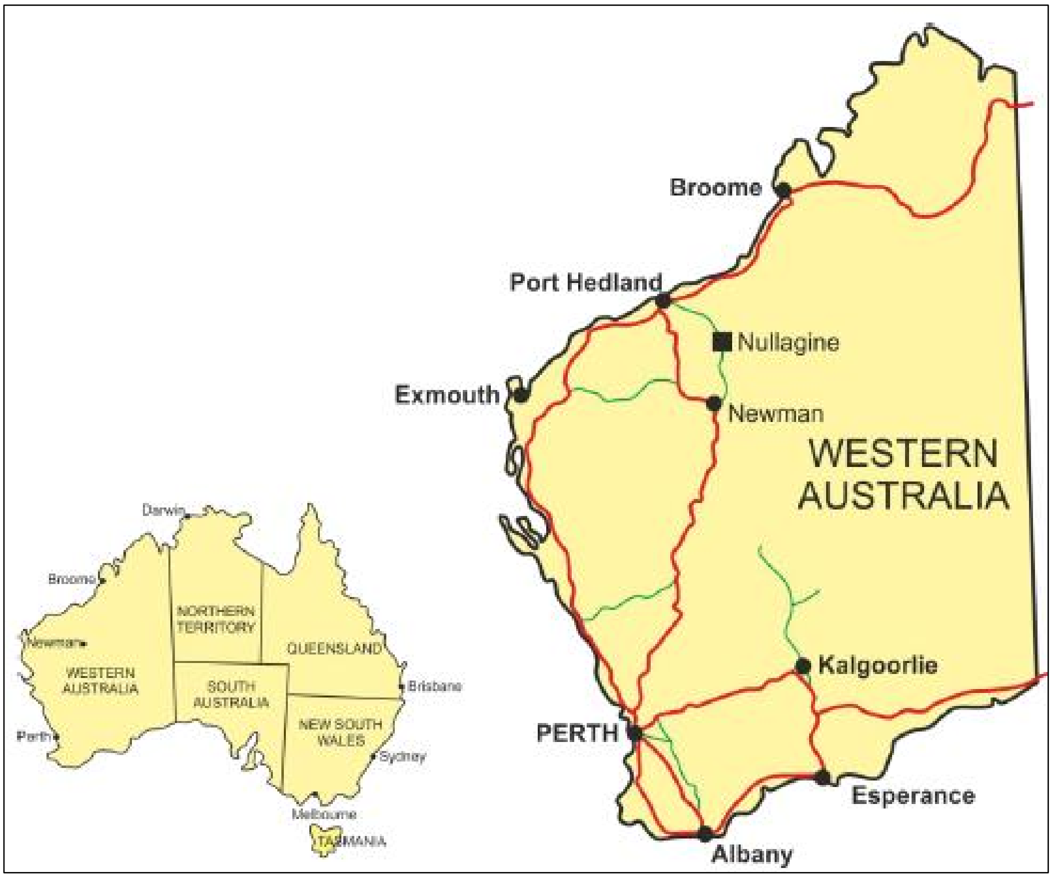
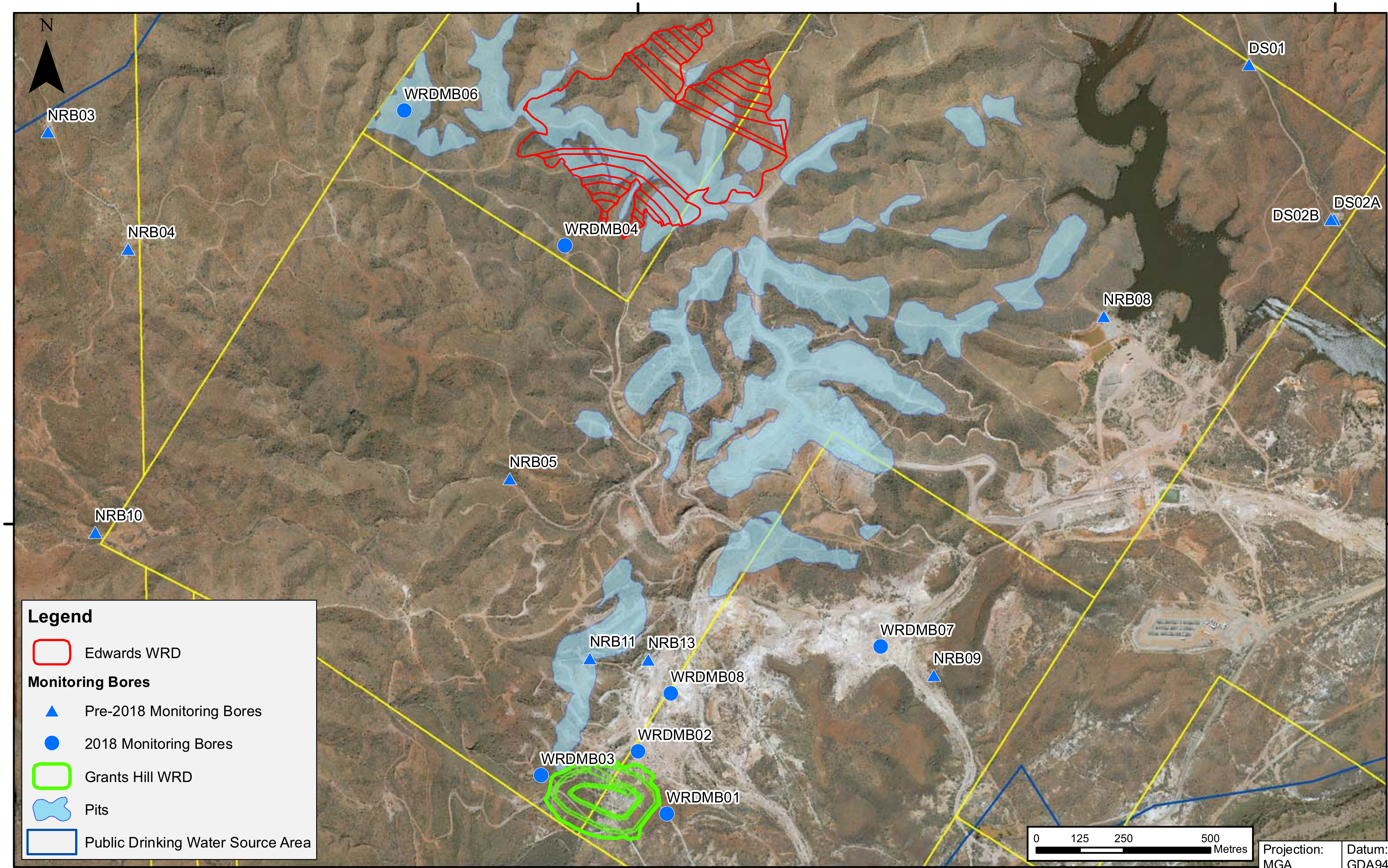


Figure 2-1: Location of Nullagine, WA

The project is composed of a contiguous block of mining tenements located approximately 2 km northwest of the locality of Nullagine. The project location and the proposed mine layout are shown in Figure 2-2, and a list of tenements provided in Table 2-1.

The proposed Beatons Creek Project is located within the Nullagine Water Reserve (Waters and Rivers Commission, 1999) which was gazetted under the *Country Areas Water Supply Act 1947* (CAWS) on 2 March 2001. The project area is currently within designated P1 and P3 Drinking Water Source Protection Areas (DWSPA, Department of Water 2004). Mining is identified as a conditional activity within P1 Source Protection areas.



Projection: MGA	Datum: GDA94
Central Meridian/Zone: Zone: 51	
Date: 9/08/2018	Compiled by: MVM
Project No. NOV005	Fig No. 2-2

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Beatons Creek - Proposed Mine Site Layout

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Date: 9/08/2018

Table 2-1: Mining tenements comprising the Beatons Creek Gold Project

Tenements	Hectares	Drinking Water Reserve	Proposed Activity
M46/09	248.0	P1	Mining
M46/10	121.1	P1	Mining
M46/11	465.0	P1	Mining
M46/529	134.6	P1	Mining
P46/1806	134.6	P1	Mining

Salient aspects of the current proposed mining layout, with respect to conducting a hydrogeological assessment, include the following:

- No processing of material is to be conducted on site.
- No tailings storage is proposed on site.
- Mining is proposed above the water table within oxidised material, with no requirement for dewatering.
- Water supply will be sourced from bore fields under existing Permits to Take Water for tenements in the proposed mining area.
- Waste rock characterisation suggests that waste rock is composed primarily of neutral (i.e. non PAF) material, with a small amount of low capacity PAF material (<5%) present
- Waste rock dumps (WRDs) will be constructed using valley fill techniques on site and are designed to reduce contact between infiltrating meteoric water and any low capacity PAF material.
- All PAF material is proposed to be encapsulated into purpose-designed PAF cells, which are located above the water table.

2.2 Previous studies and available data

Several geological and hydrogeological field programs and studies have been completed on the Beatons Creek project site and were made available for this assessment. These include the following:

- Geological and resource drilling completed by Novo, made available in digital format
- Water supply drilling as part of a road upgrade program completed by the Department of Public Works (see Appendix A – Hydrogeology Exploration Drilling)
- A permeability testing program (slug tests) completed by Novo in 2014 on existing geological resource bore holes
- Hydrogeological baseline, monitoring and production bore drilling completed by Pendragon in 2015
- Hydrogeological exploration for water supplies (KCB, 2015 – Appendix A)
- Water quality sampling and analysis, including stable isotope analysis, completed by Pendragon in 2015 (see Appendix B – Water chemistry and stable isotope data)
- Waste rock geochemical characterisation memorandum, completed by SRK (2015, 2018)
- Pumping test program completed by Novo and interpreted by KCB (see Appendix C – Pumping Test Results)
- Water levels collected by Novo and KCB for 2015.

In addition to the previously completed studies, additional studies have been completed by SRK including:

- Monthly sampling of monitoring bores in the Project vicinity for the period November 2017 to present
- Drilling programs to establish additional monitoring bores in the vicinity of the proposed PAF encapsulation cells
- Additional drilling and resampling/ analysis as part of an expanded lithogeochemical characterisation program.

2.3 Regulatory framework

With the exceptions of stock and domestic use, groundwater use must be licensed under the *Rights in Water and Irrigation Act 1914* (the Act) by the Department of Water and Environmental Regulation (DWER). Before a Licence to Take Water is issued to an applicant, DWER undertakes an assessment, including an evaluation of the potential impacts of taking the groundwater. On occasions, the DWER requires additional information in order to make an informed decision on the application. These may include cases where the proposed volume of water to be abstracted is large, the available data for the aquifer are limited, the demand for accessing a particular groundwater resource is high, or the potential impacts on the groundwater system and/ or adjacent users as a result of abstraction are considered significant.

The ranking criteria for identifying the level of assessment required for a groundwater abstraction licence application is presented in Table 2-2. Using these criteria as a guide, the licence applicant may be requested by DWER to undertake an additional hydrogeological assessment to determine the potential impacts of the proposed abstraction.

As the Beatons Creek Project is within a P1 Drinking Water Source Protection Area, DWER has requested that an H2 level of assessment be completed to support the mining proposal for the site (email dated 29 October 2014).

Table 2-2: Department of water assessment level criteria – points allocation

Volume Requested (kL/yr)	Level of Allocation (Utilisation as Percentage of Sustainable Yield)	Potential for Unacceptable Impacts		Existing Salinity (mg/L)
		Other Users	Groundwater Dependent Ecosystems	
<10,000 (0 points)	0 to <30% (C1) (0 points)	Impacts unlikely (0 points)	Impacts unlikely (0 points)	Fresh <500 (4 points)
10,001 – 50,000 (2 points)	30 to <70% (C2) (1 point)	Impacts possible (2 points)	Impacts possible (2 points)	Marginal 500 – 1500 (3 points)
50,001 – 250,000 (4 points)	70 to <100% (C3) (3 points)	Impacts likely (5 points)	Impacts likely (5 points)	Brackish 1,501 – 5,000 (2 points)
250,001 – 500,000 (6 points)	100% and over (C4) (5 points)			Saline 5,001 – 50,000 (1 point)
500,001 – 1,000,000 (8 points)	0 to <30% (C1) (0 points)			Hypersaline >50,000 (0 points)
1,000,000 – 2,500,000 (15 points)				

Source: DWER, 2009.

Table 2-3: Department of water assessment level criteria – grade assignment

Number of Points	Assignment	Required Level of Assessment
0–7 points	None (unless other knowledge of risks indicates that H1 is warranted).	None
8–2 points	H1	Desktop hydrogeology assessment sufficient
12–18 points	H2	Basic field hydrogeological assessment, including drilling and test pumping, is required
>19 points	H3	Detailed field hydrogeological assessment, including drilling, test pumping and groundwater modelling, is required

Source: DWER, 2009.

2.4 Public Drinking Water Supply Reserve

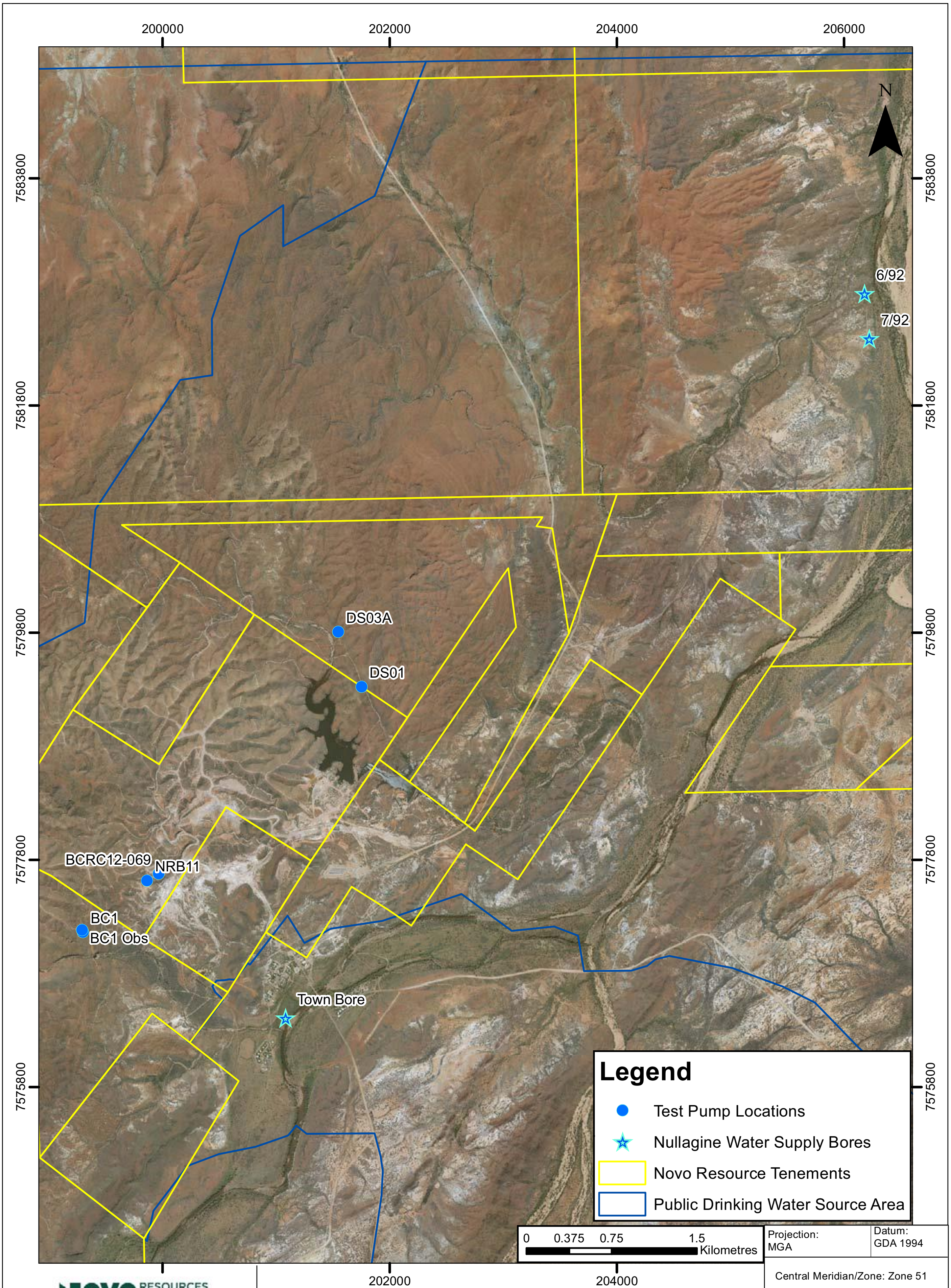
The DWER is responsible for managing and protecting Western Australia's water resources under the *Country Areas Water Supply Act* (1947). The Department has developed policies for the protection of public drinking water source areas (PDWSAs) that include three levels of priority classification. P1 source protection areas are defined to ensure that there is no degradation of the water source. P1 areas are managed in accordance with the principle of risk avoidance and land development is generally not permitted.

The Beatons Creek Project site is located within the Nullagine Public Drinking Water Source Area (PDWSA) P1 protection zone. On this basis, Novo is required to complete a hydrogeological investigation to demonstrate that the proposed mining activities will not impact the Nullagine drinking water supply.

2.4.1 Nullagine water supply bores

The settlement of Nullagine is supplied water via three bores operated by the Water Corporation and licensed for abstraction of 80 ML/a. Drinking water is supplied from bore 6/92 and bore 7/92, located approximately 8 km northeast of the settlement of Nullagine. The bores extract water from the Mosquito Creek Formation Aquifer (MCFA) from depths between 29 m and 89 m below surface. These bores have been constructed immediately adjacent to significant alluvial deposits associated with the Nullagine River, and are likely recharged from surface water infiltrating through the alluvial material into the MCFA in these locations.

An additional bore, referred to as the "Town Well" is located within the settlement of Nullagine, and is exploiting the alluvial aquifer from a depth of approximately 11 m. The Town Well is used exclusively for irrigation purposes (WRC, 1999). Locations of the bores are shown in Figure 2-3.



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Beatons Creek - Location of Nullagine Water Supply Bores

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Projection: MGA	Datum: GDA 1994
Central Meridian/Zone: Zone 51	
Date: 1/08/2018	Compiled by: KAllan
Project No. NOV005	Fig No. 2-3

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Revision: A Date: 1/08/2018

2.5 Existing permitted water use

Two licences to take water are currently valid on Tenement M46/11. The details pertaining to these licences are presented in Table 2-4. The existing groundwater licence has been granted to Novo subsidiary Beatons Creek Gold Pty Ltd. Under the terms of this licence, Novo is permitted to abstract 90,000 kL of groundwater from the fractured rock aquifer per year. No water has been abstracted for the past three years (July 2015 to June 2018). Beatons Creek Gold Pty Ltd also maintains a surface water abstraction licence for the Beatons Creek Dam.

Table 2-4: Licensed groundwater abstraction in the Project area

Licence Number	Licence Type	Issue Date	Expiry Date	Licence Allocation (kL)	Licence Address	Parties	Aquifer
178635	Groundwater	03/05/2017	02/05/2026	90,000	M46/11	Beatons Creek Gold Pty Ltd (Novo)	Fractured Rock
183394	Surface Water	21/09/2016	20/09/2026	80,000	M46/11, M46/9, M46/262, M46/186	Beatons Creek Gold Pty Ltd (Novo)	N/A

2.6 Existing water use

There are no additional known water uses located within the vicinity of the Project.

2.7 Water requirements

Preliminary water supply estimates are provided in Table 2-5. Water is proposed to be sourced from a borefield located on the Project site. Under the current submission, no processing is proposed on site, and no camp is proposed. The only requirement for water will be for dust suppression and mining purposes.

Table 2-5: Water supply requirements

Demands	kL/day	kL/annum
Dust suppression	173	63,145
Net water requirement	**173**	**63,145**

3 Conceptualisation of the groundwater system

3.1 Climate

The Beatons Creek Project is located in a semi-arid region of Western Australia. In this area, rainfall is highest for the period December to March, when approximately 70% of the average annual rainfall occurs. However, rainfall is considered unreliable from year to year. Long-term rainfall data for the Nullagine weather station (site number 004027; latitude 21.89°S, longitude 120.11°E), approximately 10 km north of the Project (Bureau of Meteorology, 2011) is displayed in Table 3-1.

Table 3-1: Nullagine Rainfall Data (1897-2004)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	69	69	50	23	20	25	11	7	2	4	12	39	335
Decile 1 Rainfall (mm)	9	6	0	0	0	0	0	0	0	0	0	3	167
Decile 9 Rainfall (mm)	143	193	149	76	59	66	32	26	3	11	37	78	489
Highest Rainfall (mm)	299	235	255	184	157	185	91	77	36	81	96	263	693
Highest daily Rainfall (mm)	145	105	192	153	74	96	74	50	30	38	55	147	192
Mean No. days of rain	6.6	6.3	4.2	2	2.4	2.3	1.4	1.1	0.3	0.6	1.8	4.1	33.1

Note: Rainfall data is based on records provided by the Bureau of Meteorology.

The Nullagine rainfall record, with rainfall data recorded from 1897 to 2004, indicates monthly rainfall typically varies from 2 mm (September) to approximately 70 mm (January), with an annual average of approximately 335 mm. The rainfall data also includes the average, decile 1 (10 percentile), decile 9 (90 Percentile) and highest recorded daily, monthly and annual rainfall.

There is limited evaporation data available for the region surrounding Nullagine. However, evaporation monitoring has been conducted at the Marble Bar weather station (site number 004020; latitude 21.18°S, longitude 119.75°E), approximately 80 km north of the GEM (Bureau of Meteorology, 2011), and is displayed in Table 3-2.

Table 3-2: Marble bar evaporation data (1968-1988)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily Evaporation (mm)	11.4	10.4	9.7	8.6	6.5	5.4	5.4	6.3	8.7	11.0	12.7	12.9	9.1
Monthly Total (mm)	353	291	301	258	202	162	167	195	261	341	381	400	3322

Note: Evaporation data is based on records provided by the Bureau of Meteorology.

Annual evaporation is approximately 3,300 mm, almost 10 times the precipitation rate, varying from 12.9 mm/d in summer (December) to 5.4 mm/d in winter (June/ July). This trend is also observed to be uniform throughout the area, as displayed by regional maps provided by the Bureau of Meteorology.

3.2 Geology

The Beatons Creek project is located within the East Pilbara granite-greenstone terrane of the Archean Pilbara Craton of Western Australia. The Hardy Formation (HF) outcrops in the Beatons Creek area, comprising a gently dipping sequence of metamorphosed conglomerates underlain by the Mosquito Creek Formation (MCF).

The MCF is a thick sequence of siliclastic meta-sediment comprising dominantly quartz-rich arenites and shales that have undergone multiple episodes of deformation. Pelite and psammites dominate the geology throughout the area of the satellite deposits and are strongly metamorphosed. The MCF extends approximately 65 km in an east–northeast to west–southwest direction (along strike) and approximately 35 km in a north–northwest to south–southeast direction (across strike).

The MCF and HF outcrop extensively but are overlain in places by thin superficial deposits of Quaternary colluvium and alluvium associated with drainage channels. The colluvium occurs as lithic sand and gravel within drainage channels and as cobbles and boulders in outwash fans in the Beatons Creek Project area.

3.2.1 Structural Geology

Four major phases of deformation have been identified in the East Pilbara granite-greenstone terrane. The first deformation (D_1) event is characterised by tight isoclinal upright folds with associated foliation. These structures have been modified by subsequent deformation events and are typically preserved as relict inclusions within the predominant regional structures (D_2).

Structures of the second deformation (D_2) event are dominant in the East Pilbara granite-greenstone terrane and are characterised by a regional east-west foliation, east-west striking ductile shear zones, and shallowly plunging tight to isoclinal folds. D_2 structures are not visibly apparent at the Beatons Creek project site.

D_3 and D_4 structures include a series of late, brittle faults which crosscut stratigraphy and the regional foliation. At least three orientations of sub-vertical faults have been identified as part of D_3 and D_4 along northeast–southwest, northwest–southeast, and north–south orientations. Within the Beatons Creek area, D_3 and D_4 faults include the Grants Hill Fault, which has significant displacement in the area. D_3 and D_4 faults are thought to be the primary conduits for groundwater movement within the MCF and the HF.

3.3 Hydrogeology

Groundwater resources in the project areas are located within three (3) aquifers, the MCFA, the Hardey Formation Groundwater System (HFGS) and the alluvial aquifer system. The MCFA and HFGS are fractured bedrock systems with secondary porosity and are part of the Pilbara Fractured Bedrock Aquifer system. The alluvial aquifer comprises unconsolidated alluvial deposits associated with surface water drainage systems in the project area, including Cadjuput Creek, Beatons Creek and the Nullagine River.

3.3.1 Alluvial aquifers

Unconsolidated sediments are located within, and adjacent to, the river and creek beds throughout the area. The alluvium associated with these drainage systems predominately comprises sand, silt, gravels and cobbles. These systems form unconfined aquifers which overlie the basement rocks and are inferred to be hydraulically connected with the basement rock where the underlying lithology is weathered and fractured. These sediments are of limited areal extent on the Beatons Creek project site and are confined to thin deposits (i.e. less than 2 m thick) within valley bottoms. Alluvial aquifers are expected to have fluctuating water levels corresponding to seasonal rainfall patterns and are therefore not considered to form a sustainable aquifer with respect to long-term water supply.

Recharge to the alluvial aquifer occurs via infiltration from accumulated runoff during creek flows and via direct infiltration from rainfall. Groundwater levels in the alluvial, unconfined aquifer increase in response to recharge from river flows and decline once flows have ceased. The decline in groundwater levels following flow events has been previously interpreted as localised groundwater infiltration into the underlying basement rocks (Hopgood and Skidmore, 2005).

3.3.2 Hardey Formation Groundwater System

Little existing information is available on the HFGS. Observations during a site visit in February 2014 and results of hydrogeological exploration drilling (Appendix A and from additional drilling) indicate that groundwater in the HFGS occurs within faults and fractures (i.e. secondary permeability). Groundwater levels taken from open boreholes indicate that the water table closely follows the topography of the site, with many holes absent of water. This, along with the highly variable water chemistry of the HFGS, suggests that the system is highly compartmentalised, with limited interconnection between fracture systems. The ability of the HFGS to sustain extraction of water has not been established.

Conceptually, recharge to the HFGS is derived via infiltration from the overlying alluvium aquifer into the basement rock, and from direct rainfall infiltration on the basement outcrop where zones of faulting and associated fracturing are exposed. Extremely high evaporation rates in the area result in recharge being confined to episodic, heavy rainfall events.

3.3.3 Mosquito Creek Formation Aquifers

Groundwater in the MCFA predominately occurs within structural features (faults and associated fracturing) across the study area, where zones of secondary permeability with relatively high hydraulic conductivities are observed. The depth of these structural features is unknown but has previously been estimated at approximately 200 m. Hydrogeological exploration drilling completed to establish new monitoring and production bores in the area indicate that most water-bearing fractures are located between 70 m and 150 m depth (Appendix A).

Groundwater storage within the MCFA is considered limited due to the low effective primary porosity of the basement rocks. However, variations in storage occur where the basement rocks are fractured due to secondary faulting.

The MCFA outcrops extensively within the study area, but is also overlain by deposits of Quaternary colluvium/ alluvium. Recharge to the MCFA occurs via infiltration from the overlying alluvium aquifer into the basement rock fracture zones and/ or along bedding planes. Recharge also occurs from direct rainfall infiltration on the basement outcrop where zones of faulting and associated fracturing are exposed at surface. Extremely high evaporation rates in the area result in recharge being confined to episodic, heavy rainfall events.

The MCFA is the primary host of water in the region, and the main target for sustainable water production for the Project.

3.4 Recharge

Estimates for recharge into the groundwater system have been developed for use in previous modelling exercises by Hopgood and Skidmore (2005) and KCB (2010) in the area and are provided in Table 3-3. Based on an understanding of the hydrogeology from previous assessments, three distinct recharge zones were developed: direct rainfall infiltration on the exposed basement rock; direct rainfall infiltration where zones of faulting and associated fracturing are exposed; and to the alluvial aquifer, via infiltration from accumulated runoff during creek flows and via direct infiltration from rainfall.

Table 3-3: Recharge estimates for the Nullagine area

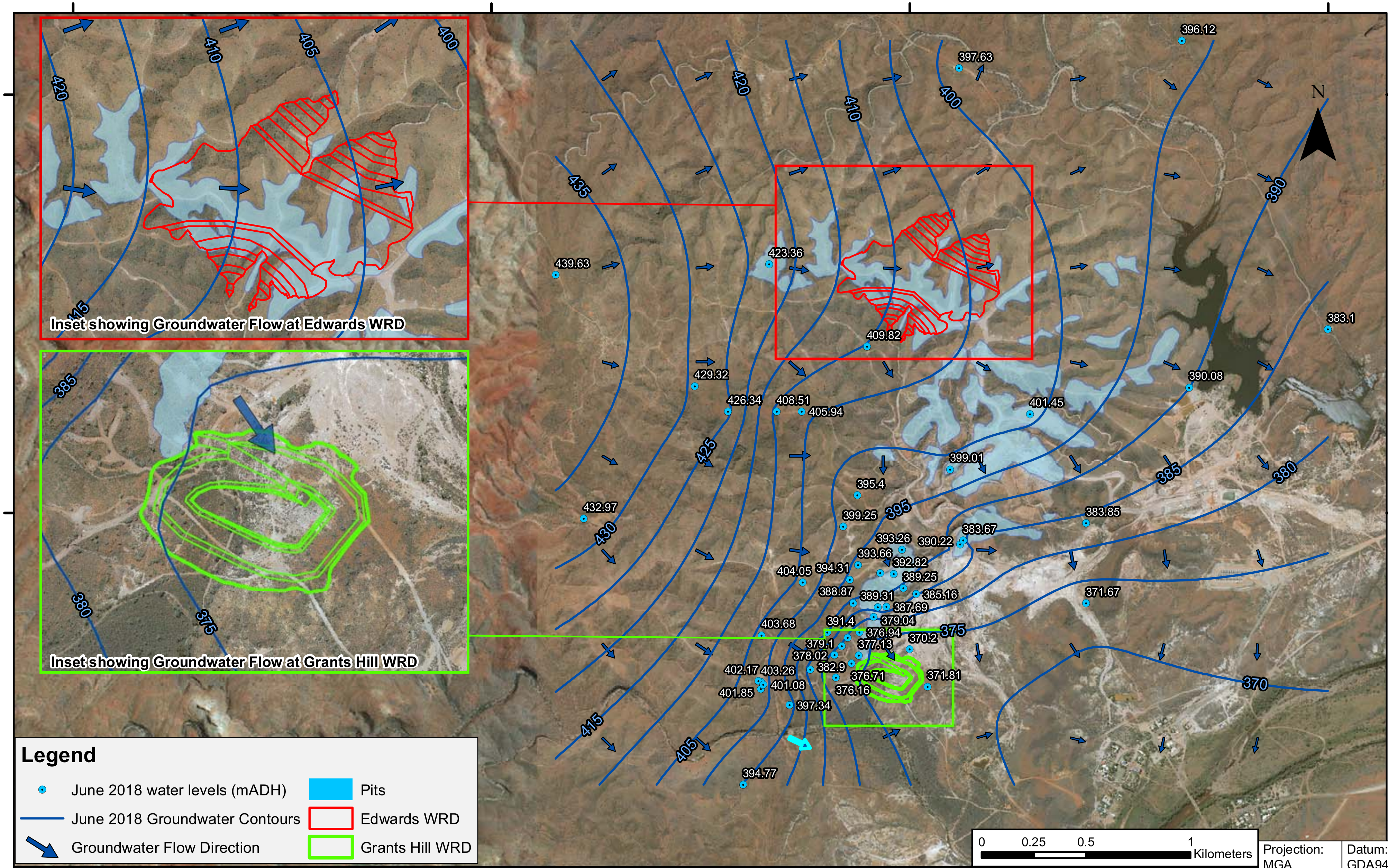
Zone	Rainfall (mm/year)	Recharge (%)	Recharge (mm/year)
MCFA	335	0.1	0.34
Fractured MCFA	335	1.0	3.4
Alluvium	335	3.0	10.1

3.5 Groundwater flow

Groundwater levels have been measured during visits to the Project site; results from 2018 are presented in Figure 3-1. Groundwater levels generally follow topography and surface catchments throughout the area with the exception of the area surrounding the Beatons Creek dam reservoir. The increase in water levels around the dam and resultant deflection of groundwater contours suggest that the dam is a losing water body and forms a hydraulic barrier to groundwater flow. As a result, water from the southern portion of the Project site flows in a southerly direction towards Nullagine, while groundwater from the northern portion of the Project site flows easterly towards the Nullagine River.

Based on the available dataset, a hydraulic gradient for flow towards Nullagine is estimated at 0.012 m/m reflective of the higher topographic grade in that general direction. The hydraulic gradient for flow towards the Nullagine River is estimated at 0.003 m/m.

The discussion on groundwater levels and flow direction assumes complete interconnectivity of the fracture systems within the MVFA and HFGS. This assumption is not supported by the highly variable water quality data (i.e. salinity), which suggest that these aquifers are composed of a series of compartmentalised, fracture-hosted systems. Therefore, this discussion assumes a higher risk of impact than is likely the case and is conservative from a water quality protection perspective.



Projection: MGA	Datum: GDA94
Central Meridian/Zone: Zone: 51	
Date: 9/08/2018	Compiled by: MVM
Project No. NOV005	Fig No. 3-1

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Beatons Creek - Groundwater Elevation and Flow Direction

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Date: 9/08/2018

3.6 Groundwater quality

3.6.1 Groundwater chemistry

Significant groundwater sampling has been completed for the Project from 2014 to 2018, covering several wet and dry seasons, and submitted for analysis for physiochemical parameters, major ions, and metals. Samples from a single round were also submitted for stable isotope analysis. A summary of previous and current sample locations is provided in Figure 3-2, and results of the analyses are provided in Appendix B. All groundwater results are derived from the MCFA and HFA fractured rock aquifers.

Background groundwater quality in the area is typical of the MCFA in the area (see Hopgood and Skidmore; 2005, KCB, 2010 for comparison) and is marginal to brackish in the area with salinity averaging 2,216 mg/L and ranging from 600 mg/L to 18,000 mg/L TDS. Where groundwater salinity in the MCFA is highest, this is nominally due to significantly higher concentrations of magnesium, sodium, chloride and sulphate. Groundwater pH is generally neutral to acidic, with elevated acidity near former mine workings. In all but one sample location (BCRC12-69), total alkalinity exceeds total acidity.

Additionally, elevated concentrations of heavy metals arsenic, cadmium, copper, manganese, lead, nickel, zinc and iron were identified (see Appendix B) in the groundwater near the proposed mining area.

Surface water is generally fresh with total dissolved solids (TDS) less than 500 mg/L. Typically, most anions and cations displayed relatively low concentrations (see Appendix B).

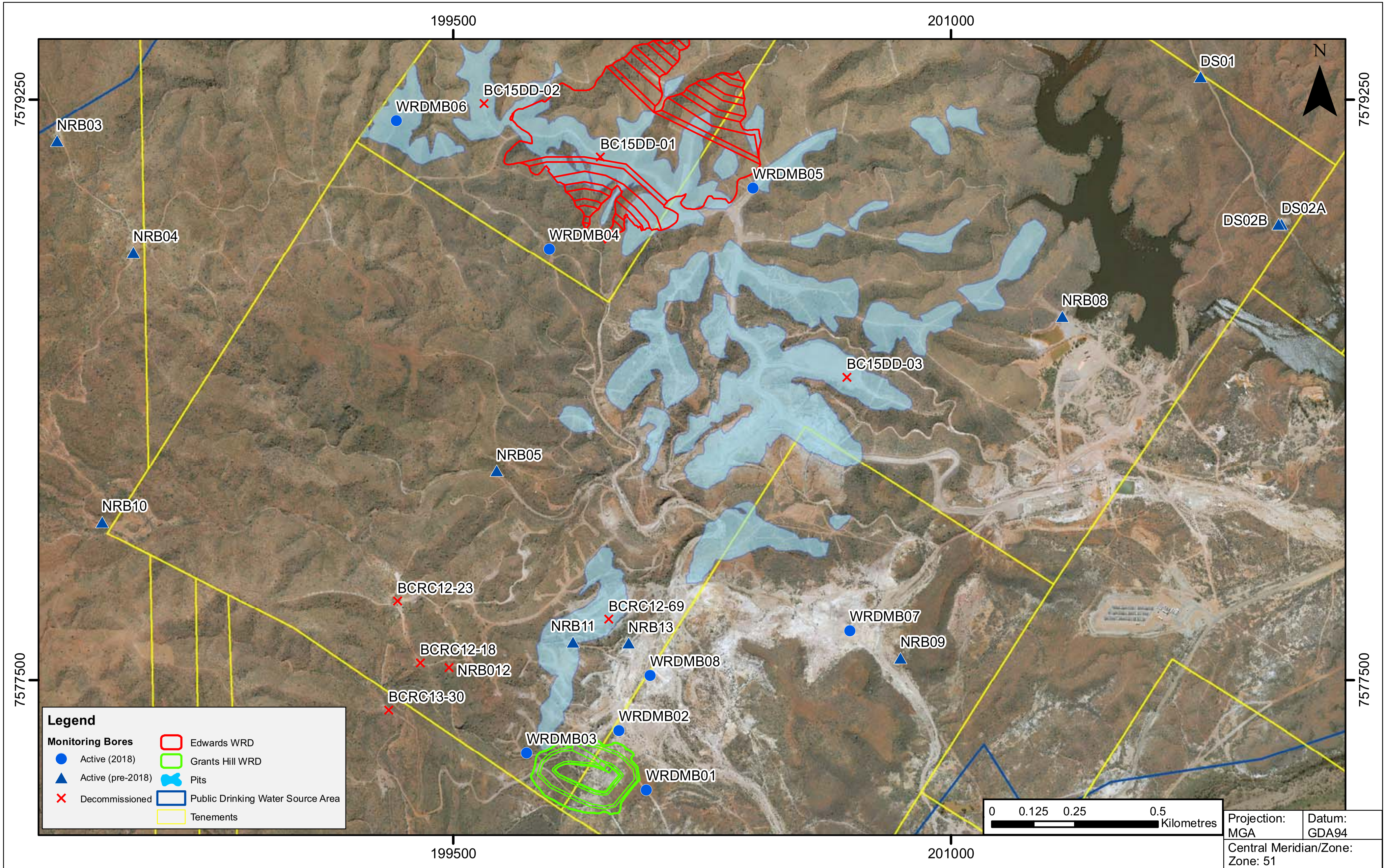
Analytical results are presented in a Piper Diagram in Figure 3-4 and in a Water-Type diagram in Figure 3-5. Interpretation of the Piper diagram suggests that surface water and groundwater at Beatons Creek is predominantly of the $Cl+SO_4$ and $Cl+SO_4$, HCO_3 types, with a range of Mg and Ca. Groundwater at Beatons Creek has a dominant $MgSO_4$ character, whilst the Nullagine town bore field does not display a dominant character.

Interpretation of the Water-Type diagram (Figure 3-5) indicates that water from the bores at Beatons Creek fall within areas indicative of dissolution/ mixing ($Ca+MgSO_4$ and $NaSO_4$), have high salinity with reverse ion exchange (NaCl), and that strongly acidic ions exceed weakly acidic ions.

Summary of groundwater chemistry

Key conclusions derived from the interpretation of the groundwater chemistry include the following:

- Groundwater within the MCFA and HFGS is brackish to saline, with elevated concentrations of metals, including exceedances of arsenic, copper, manganese, nickel zinc and iron.
- pH is generally neutral to acidic, with elevated acidity in the vicinity of former mine workings.
- Surface water is generally fresh, with less than 500 mg/L TDS.
- There is a distinct difference in composition of groundwater from the Nullagine Town Water bores and bores at Beatons Creek, suggesting that they are exploiting different groundwater systems with limited interconnectivity.



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Central Meridian/Zone: Zone: 51	
Date: 9/08/2018	Compiled by: MVM
Project No. NOV005	Fig No. 3-2

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Beatons Creek - Monitoring Bore Locations

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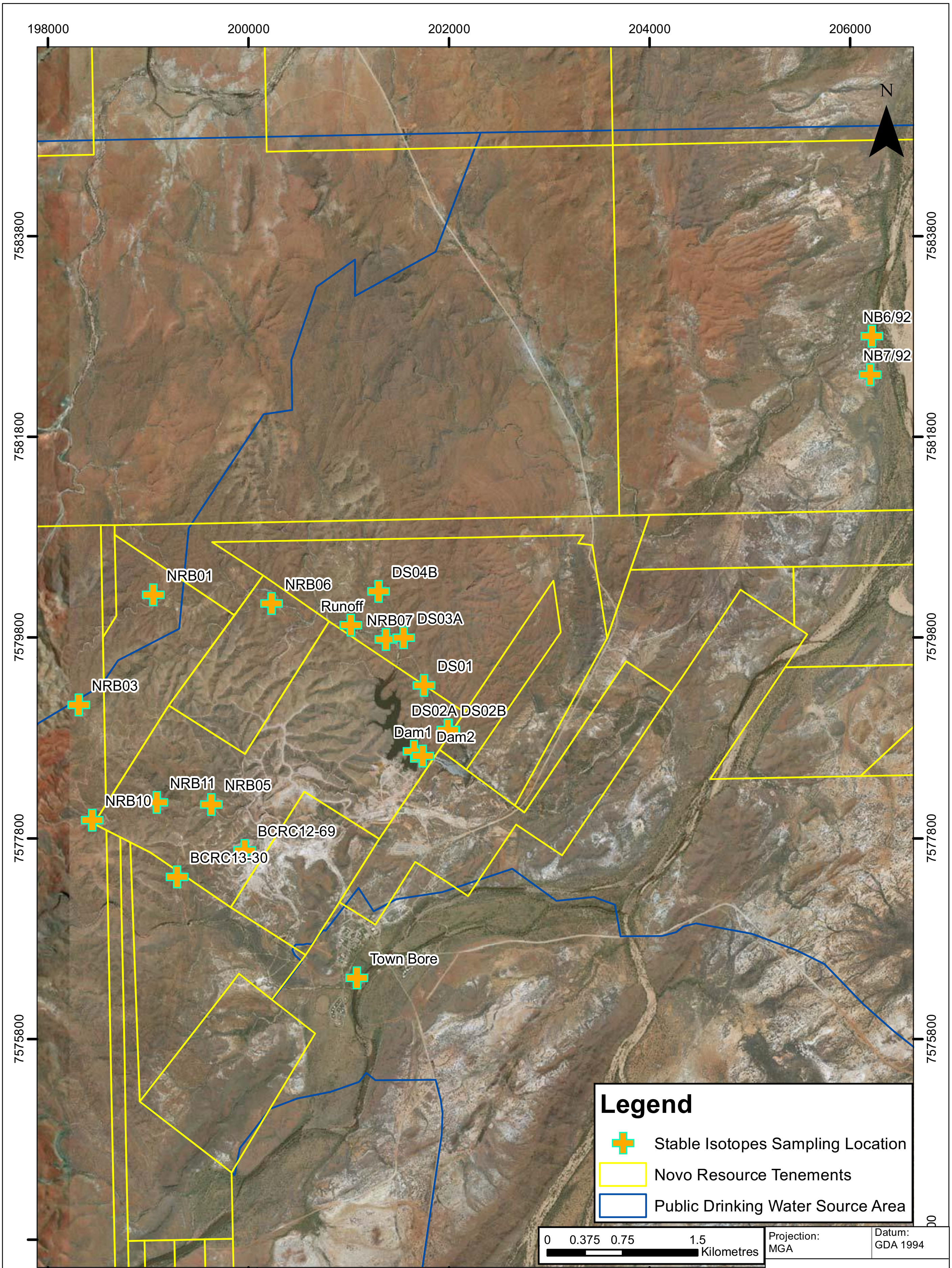

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Beatons Creek - Stable Isotope Sample Locations

Projection: MGA	Datum: GDA 1994
Central Meridian/Zone: Zone 51	
Date: 1/08/2018	Compiled by: KAllan
Project No. NOV005	Fig No. 3-3

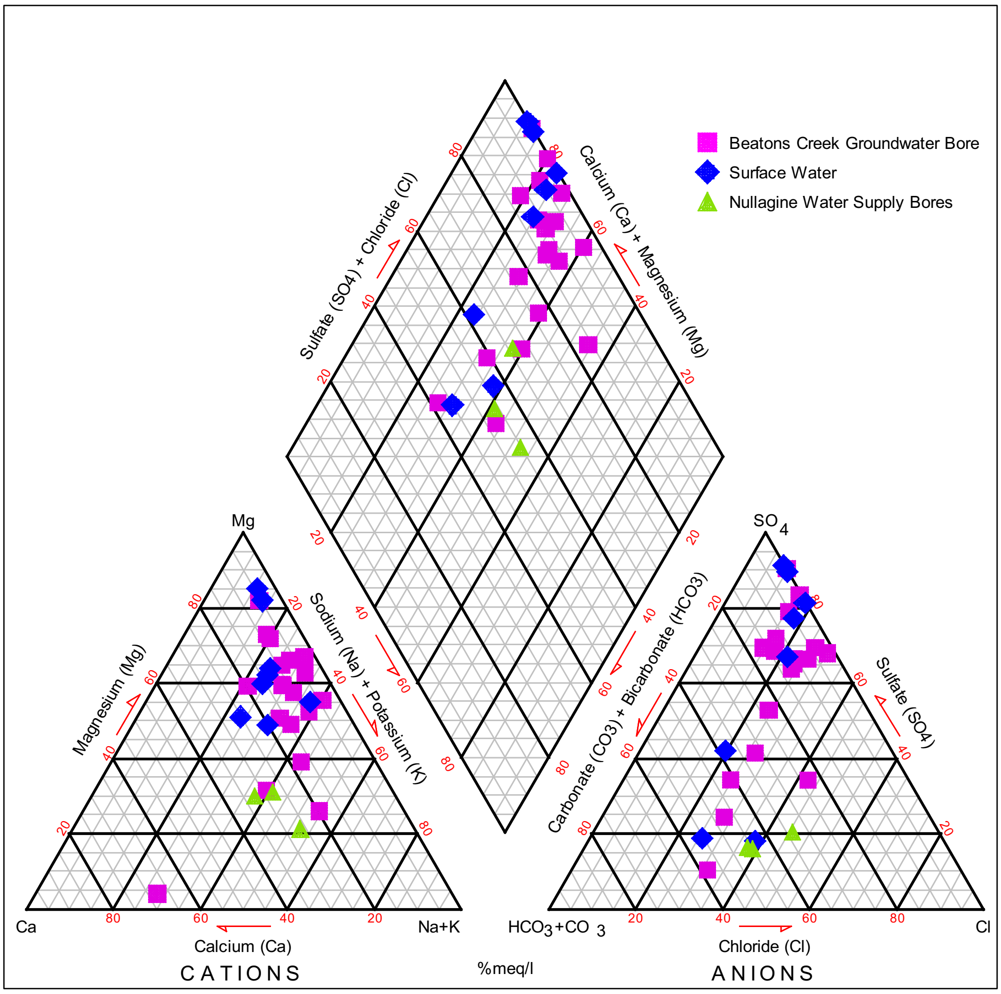

Figure 3-4: Piper diagram for samples from the Beatons Creek Project site

Source: Data from 2015 sample run

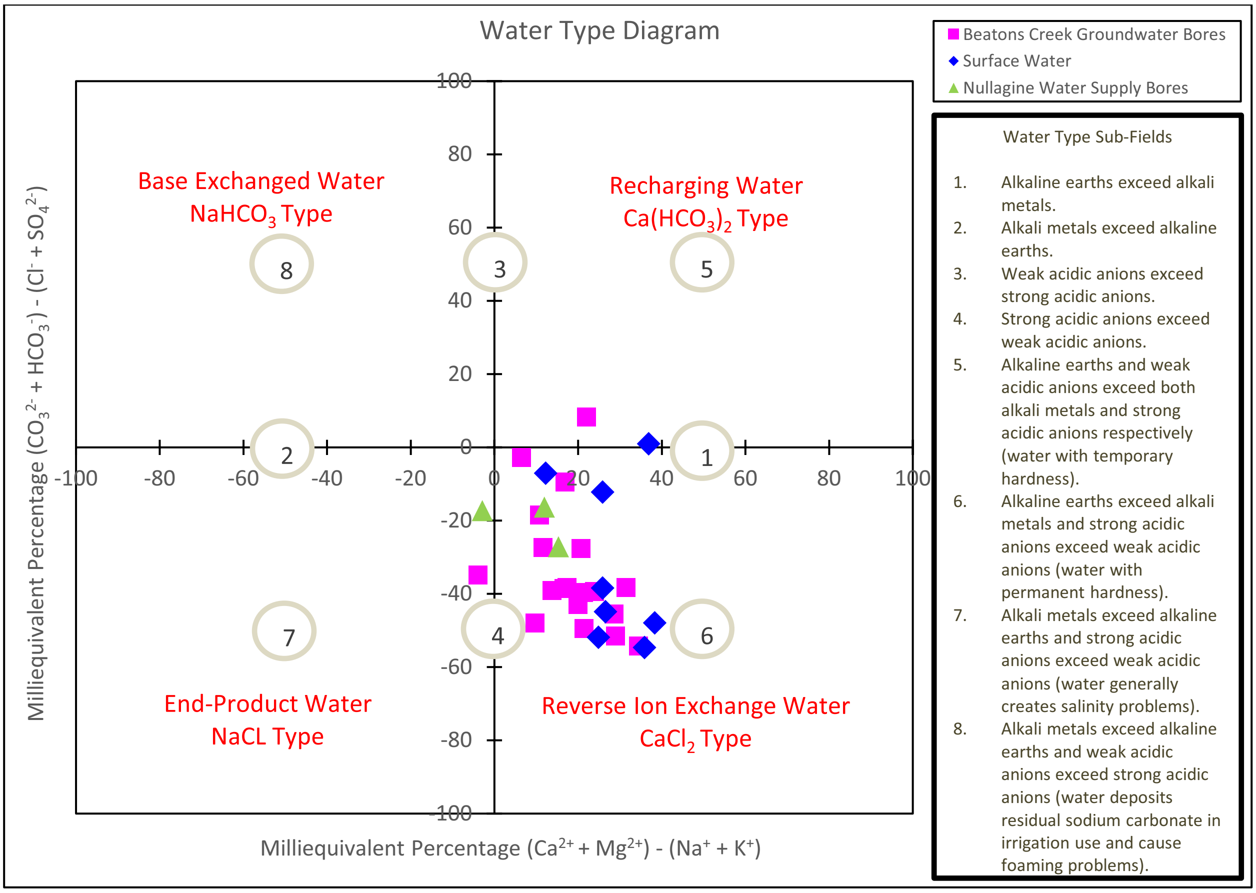

Figure 3-5: Water type diagram for samples from the Beatons Creek Project site

Source: Data from 2015 sample run

3.6.2 Stable isotope analysis

Stable isotopes are used to describe and characterise the source of water and allow further understanding of the hydrologic system. Stable isotopes within meteoric water are conserved through the hydrologic cycle and are commonly applied to distinguish between water sources, determine the origin of a specific water sample, and to derive relative residence times for groundwater samples.

Samples were obtained by Pendragon and submitted to a laboratory at the University of Kwazulu Natal in South Africa for analysis of deuterium (2H) and oxygen 18 (18O). Results of the analysis are provided in Table 3-4 and presented graphically in Figure 3-6. Water samples will typically fall along the Global Meteoric Water Line (GMWL) as long as they are ultimately derived from precipitation. Surface water samples typically plot along the upper right-hand portion of the GMWL, while groundwater samples with significant residence times plot along the lower left-hand portion.

Stable isotope analysis indicates that:

- Surface water samples from Beatons Creek dam reservoir have similar isotopic signatures (as would be expected). Deviation of these samples from the GWML is likely a result of evaporation, and indicates that water residence time in the reservoir is high, with limited interaction with the MCFA, HFGS and alluvial aquifers.
- Samples of runoff taken from the Beatons Creek streambed north of the reservoir and the Town Bore have similar sources. The sample of runoff represents the best approximation of the stable isotope ratio for rainfall in the area. The grouping between the Town Bore and the runoff sample suggests that the town bore is tapping the alluvial aquifer, and confirms that recharge in the alluvial aquifer is via infiltrating runoff.

- The ground water samples group in close proximity around the GMWL and are suggestive of long residence times.
- The Town water supply bores plot to the upper right of the bedrock bores, and represent shorter residence time, or potentially a localised or episodic mixing of water from the alluvial aquifer and the MCFA.

The alluvial aquifer of the Nullagine River is not connected to the MCFA or HFGS in the Project area.

Table 3-4: Stable isotope analytical results

Source	$d^{18}O$ Reportable Value (permil)	$d^{18}O$ Standard Deviation	$d^{2}H$ Reportable Value (permil)	$d^{2}H$ Standard Deviation
NRB01	-5.4	0.28	-31.18	1.16
NRB03	-6.21	0.03	-40.73	1.48
NRB05	-5.84	0.09	-39.3	0.29
NRB06	-5.24	0.05	-30.29	0.93
NRB07	-5.48	0.15	-33.97	0.94
NRB10	-6.06	0.21	-43.37	0.51
NRB11	-5.44	0.26	-37.81	1.7
BCRC13-30	-5.45	0.27	-42.01	1.44
BCRC12-69	-5.85	0.29	-38.67	1.59
DS01	-5.71	0.24	-38.36	1.42
DS02A	-5.32	0.19	-34.81	1.15
DS02B	-5.47	0.17	-39.1	0.53
DS03A	-5.72	0.14	-39.32	0.6
DS04B	-6.53	0.15	-41.45	1.14
Town Bore	-1.34	0.22	-14.41	1.82
NB7/92	-4.57	0.2	-32.51	1.11
NB6/92	-5.23	0.23	-35.45	1.23
Dam1	6.21	0.12	19.85	1.33
Dam2	1.44	0.12	5.75	0.66
Runoff	-1.27	0.07	-5.23	1.76

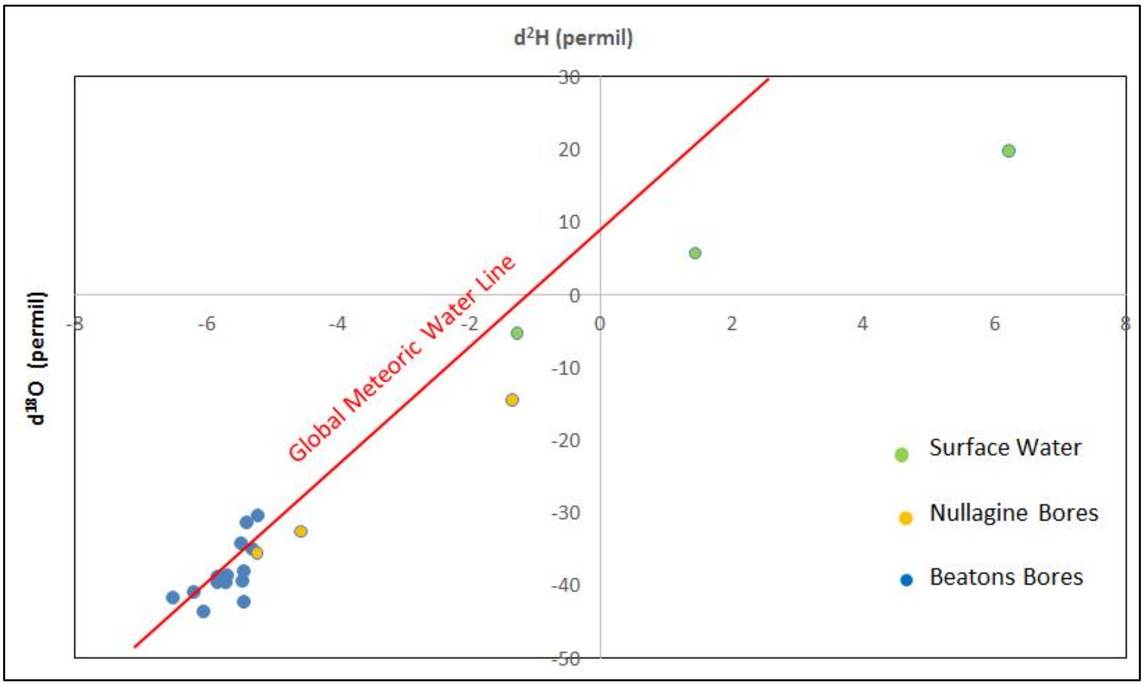

Figure 3-6: Stable isotope analysis results

3.7 Hydrostratigraphy

3.7.1 Layer 1 – Alluvial Aquifer

The alluvial aquifer is present as thin (i.e. <2 m thickness) deposits of sand and gravel within drainage channels and as cobbles and boulders in outwash fans in the Beatons Creek Project area. These deposits are of limited areal extent and thickness such that they are not a significant aquifer within the project site. The most important function of the alluvial aquifer is to provide a potential source of recharge (via infiltrating runoff) into the underlying fractured bedrock aquifer. Stable isotope analysis, however, indicates that there is no interaction between the alluvial aquifer and the underlying bedrock aquifer. This suggests that the alluvial aquifer discharges directly into the surface water system in the Beatons Creek Project area, and differs from preliminary conceptualisations of the hydrogeological system, where the alluvial aquifers are considered important sources of recharge to the MCFA. It is not clear from the available data if this is a local phenomenon or is ubiquitous through the MCFA.

Due to the limited thickness, spatial distribution and the lack of interaction between the underlying fractured rock aquifer, no pumping tests were completed from bores within the alluvial aquifer and the alluvial aquifer has not been identified for water supply.

3.7.2 Layer 2 – Fractured Bedrock Aquifer

The fractured bedrock aquifer is the primary focus of the groundwater investigation in the area. The fractured rock aquifer (both the MCFA and HFGS) is host to secondary, fracture-controlled permeability. Conceptually, the fractured bedrock aquifer is composed of a series of highly compartmentalised fracture systems, with highly variable interaction between them, hosted within a sequence of recrystallized and metamorphosed sedimentary units. Matrix permeability is considered extremely low to negligible, with transmissivity within bores a direct function of the number and aperture of fractures encountered during drilling.

Drilling carried out on site, as part of a hydrogeological exploration program (Appendix A), encountered extremely low yields from bores, and where measurable, air lift yields were associated with significant fractures zones. This also supports the interpretation that the permeability in the fractured bedrock aquifer is secondary with negligible matrix permeability. This is further supported by pumping test data, where drawdown in the pumping bores has a defined inflection point representing the dewatering of the fractures system (Figure 4 in Appendix C).

Higher permeability is associated with fracture zones, particularly within the contact zone surrounding a large north-northwest striking, sub-vertical dolerite dyke located immediately east of Beatons Creek Reservoir.

3.7.3 Beatons Creek pumping test program

An aquifer testing program was completed at Beatons Creek to allow for the estimation of aquifer hydraulic parameters, interpretation of hydrogeological characteristics and to develop recommendations for a sustainable water supply for the project. Constant rate tests were conducted on bores BC01, BCRC12-069 and DS01, all located in the fractured bedrock aquifer (Figure 2-3). Hydraulic parameters estimated from the tests are presented in Table 3-5, with detailed report of the test pumping program presented in Appendix C.

Transmissivity values for late time pumping data ranged from 5.5 m^2/day to 8.4 m^2/day and from 18.1 m^2/day to 25.3 m^2/day for recovery data, which are within normal ranges for fractured rock aquifers. Estimated hydraulic conductivity (k) values are considered tentative due to the uncertain aquifer thickness yet represent the best estimate for the fractured bedrock unit. Estimated storage values range from 3.9×10^{-5} to 8.56×10^{-3}, which is consistent with fractured rock aquifers.

Slow recovery within pumped bores and observation bores, coupled with a noted delayed recovery within observation bores following termination of pumping (water levels in some observation bores continued to drop after pumping was terminated), are interpreted to represent very limited aquifer storage within the fractured bedrock aquifer. Analysis of pumping test data assumed an isotropic, homogeneous aquifer – conditions not met within a fractured rock system – and as a consequence, aquifer storage values are likely overestimated.

Table 3-5: Pumping test results

Aquifer	Bore ID	Bore Type	Drilled Depth (m)	Screened Interval	Static Water Level (mbTOC)	Abstraction Rate (L/s)	Test Duration (hours)	Drawdown (m)	Hydraulic parameters					Comments
									T (m^2/day) (Late time pumping)	T (m^2/day) (Recovery)	K (m/day)	S (dimensionless) (pumping)	S (dimensionless) (recovery)	
Dyke	DS01	Pumping	132	72 -132	8.08	5.2	72	16.03	8.4	19.3	3.22E-01	6.91E-03	3.96E-05	Pumping S should be ignored due to well losses.
	DS03A	Observation	118	12 - 112	3.13	N/A	72	11.5	8.4	21.9	2.19E-01	8.63E-03	2.69E-05	S values should not be calculated from recovery data.
Bedrock	BC1	Pumping	Unknown	Open Hole	6.02	1.6	148	34.89	6.3	25.3	N/A	N/A	3.34E-02	N/A
	BC1 (Obs)	Observation	Unknown	Open Hole	5.97	N/A	148	11.6	5.5	18.1	NA	5.80E-04	1.75E-02	S values from recovery data should not be considered. Observation S during pumping is reasonable for low K aquifer.
Bedrock	BCRC12-069	Pumping	120	42 - 114	41.66	4.8	14.5	40.81	N/A	N/A	N/A	N/A	N/A	Storage was depleted during the test. No hydraulic Parameters could be calculated.
	NRB11	Observation	132	24 - 90	10.84	N/A	14.5	7.66	N/A	N/A	N/A	N/A	N/A	

3.8 Summary of hydraulic parameters

A summary of aquifer properties and hydraulic parameters is provided in Table 3-6.

Table 3-6: Summary of aquifer properties and hydraulic parameters

Zone	Hydraulic Conductivity (m/d)		Storage (dimensionless)		Hydraulic gradient (m/m)		Recharge (mm/year)
	From	To	From	To	Southward	Eastward	
Alluvial Aquifers	N/A	N/A	N/A	N/A	N/A	N/A	10.1
Fractured Bedrock	0.005	0.05	1.75E-02	5.80E-04	1.25E-2	3.13E-3	3.4
Dyke Contact Zone	0.22	0.32	6.91E-03	8.63E-03	N/A	N/A	0.34

4 Water Supply

4.1 Existing water sources

Available water sources on the site include an existing dam and two production bores (DS01 and DS02) located on tenement M46/11. A summary of bore construction details is presented in Appendix A. Pumping tests were completed and data were analysed to develop an estimation of sustainable water supply from the bores.

4.2 Sustainable yield

4.2.1 FC Method

Results obtained from short-duration test pumping programs using conventional analytical solutions do not take into consideration the heterogeneity of the aquifer being tested, and often do not adequately describe the drawdown response to pumping. This often results in an overestimation of the sustainable yield for production bores. Therefore, conventional models developed for homogeneous porous aquifers may not be viable in fractured rock systems.

The Flow Characteristic (FC) method (van Tonder et al., 1998) has been specifically developed to develop sustainable yields of bores from pumping test data in fractured rock aquifers. The method is an applicable analytical tool for the MCFA because of its heterogeneous nature, fractured rock aquifer characteristics and presence of physical hydraulic boundaries (fault structures, dykes etc.).

The FC method developed by van Tonder et al., (1998) was used to develop preliminary estimates of sustainable yield for production bores on the project site.

4.2.2 Results

DS01 was drilled on the edge of a North-South trending dyke. All fracturing associated with dyke structures is limited to a narrow zone adjacent to the dyke. This results in a ‘thin linear aquifer’ with a higher permeability than the adjacent country rock. For the purposes of the estimation of the sustainable yield, the dyke and adjacent country rock are considered as ‘no-flow’ boundaries (two no-flow boundaries) and most water is taken from the fracturing on the fringe of the dyke. The poor recovery data support the theory that adjacent rock has a low permeability and does not significantly contribute to the recharge of the thin linear aquifer adjacent to the dyke.

The following assumptions were used in the estimation of the sustainable yield:

- Extrapolation time – 5 years
- Pumped for 24 hours per day
- 0 mm annual effective recharge
- Available drawdown – 75 m
- Two no-flow boundaries (dyke and adjacent country rock).

Using the above assumptions with the FC method, a sustainable yield of 3.8 L/s (~119,000 kL/year) has been estimated for the bores. This exceeds the proposed Project water requirement by two-fold.

5 Groundwater impact analysis

Several concerns have been flagged through consultation with the DWER over the proposed mine site specific to groundwater; these include:

- Location of the proposed mining activity and groundwater abstraction within the Nullagine Public Drinking Water Source Area (PDWSA) P1 protection zone and potential impacts on the Nullagine drinking water supply
- Potential impacts in the vicinity of PAF encapsulation cells
- Potential impacts on the groundwater levels, yields and water quality
- Potential impacts on GDEs
- Potential impacts on stygofauna.

5.1 Nullagine public drinking water supply

No water abstraction is being requested on the Beatons Creek project site as part of the Mining Proposal; however, the site is located within the Nullagine Drinking Water Supply Water Reserve. The specific goal of this study, therefore, is to determine potential impacts the proposed mine activities may have on the Nullagine drinking water supply bores.

Assessment of the potential impacts on the water supply bores was completed by identifying the likely source of contamination and the potential flow paths to receptors.

5.1.1 Waste rock/ source characterisation

A geochemical assessment of the material to be mined at the Beatons Creek Project has indicated that the waste rock contains limited sources of acidity, which resulted in low paste pH and negative acid neutralising capacity (ANC). Waste rock material is classified in the NAF to Uncertain to PAF range, with all PAF materials considered low capacity PAF (SRK, 2015).

The conceptual design for the proposed WRDs is to encapsulate the low capacity PAF material and direct any infiltrating water away from the material within two PAF cells, nominally the Grants Hill and Edwards PAF cells (See Figure 3-1 for locations). The classification of the material within the NAF to low capacity PAF range, and the proposed designs mitigate the potential for development of acidic and metalliferous seepage from entering the groundwater system.

Groundwater levels were measured from a number of open holes and monitoring bores across the site in June 2018, and are presented in Figure 3-1. These measurements were used to develop maximum potential groundwater levels in the vicinity of the respective PAF cells; indicative cross-sections through the cells are provided in Figure 5-1 and Figure 5-2. Groundwater levels are below the base of the proposed excavations and the PAF cells, providing a buffer to any potential migration of seepage from the PAF cells.

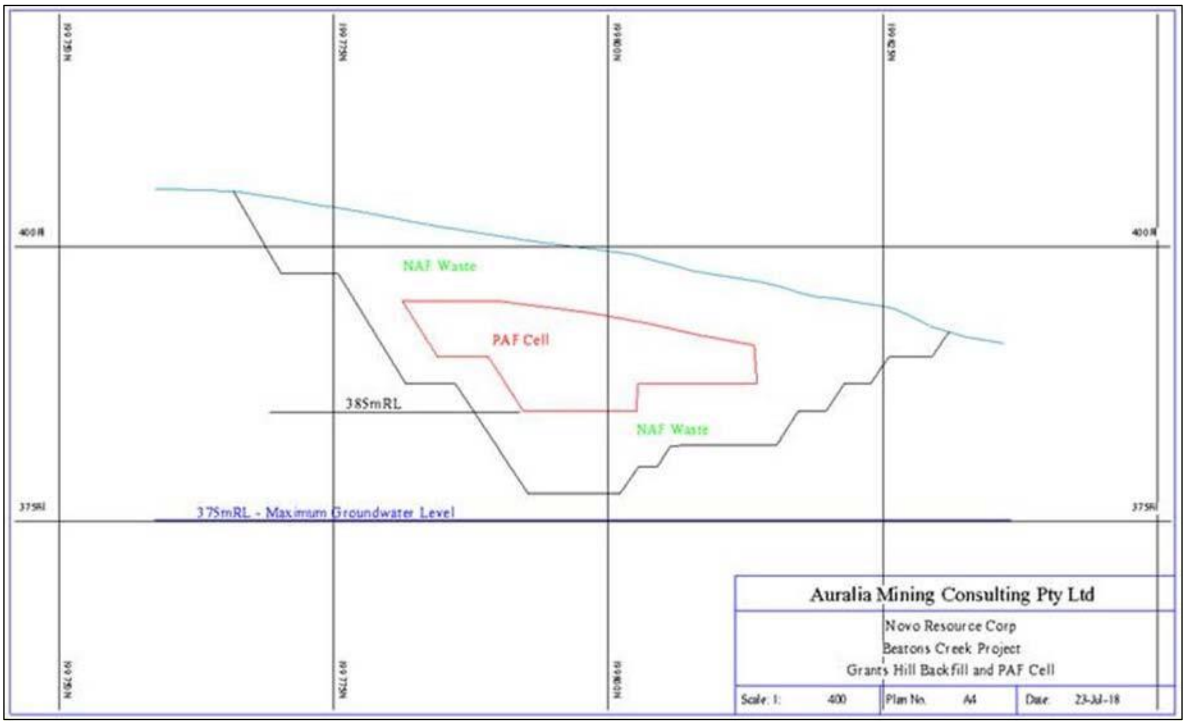

Figure 5-1: Section through Grants Hill PAF cell layout with maximum measured water levels

Source: Figures provided by Aurelia via email, 2018

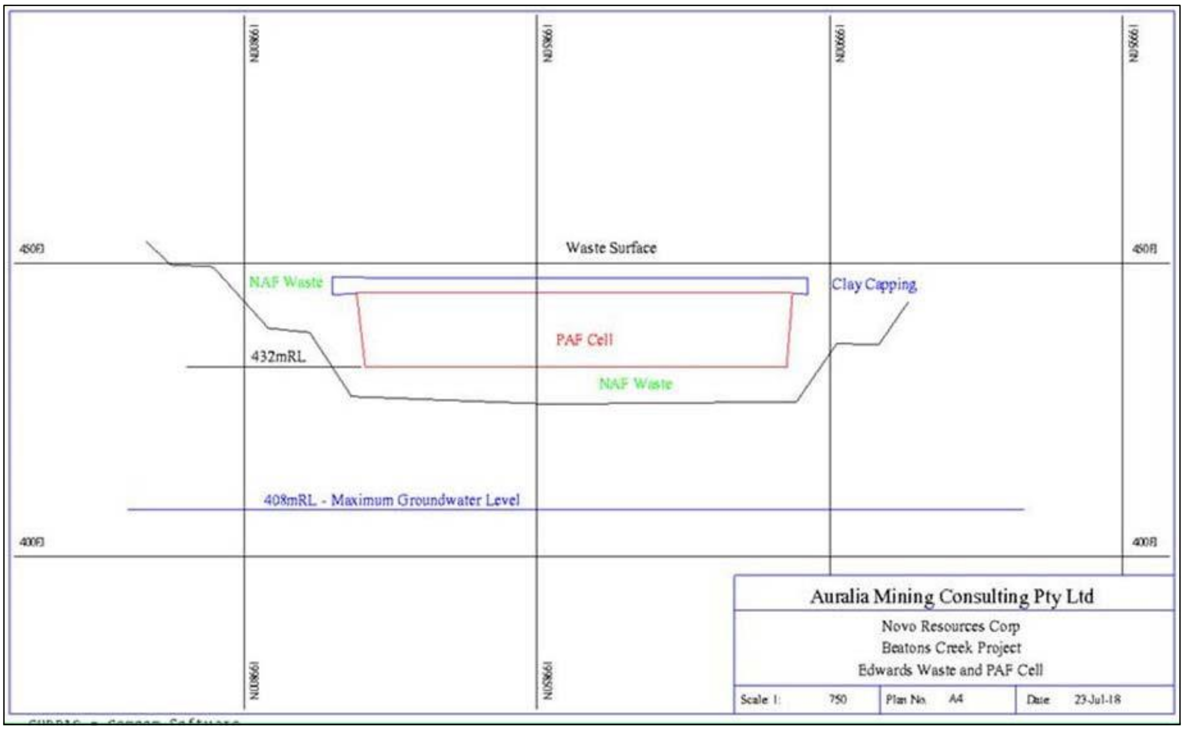

Figure 5-2: Section through Edwards PAF cell layout with maximum measured water levels

Source: Figures provided by Aurelia via email, 2018

5.1.2 Nullagine water supply bores

The settlement of Nullagine is supplied water via three bores, operated by the Water Corporation, and is licensed for abstraction of 80 ML/a. Drinking water is supplied from three bores for drinking water and irrigation purposes (Figure 2-3 and Table 5-1). Bores 6/92 and bore 7/92 are located approximately 8 km northeast of the settlement of Nullagine, and 8 km east of the Project site. These bores exploit the MCFA. An additional bore, the 'Town Well' located within the settlement of Nullagine, approximately 2 km south of the Project site, is used exclusively for irrigation purposes and exploits the alluvial aquifer.

Table 5-1: Nullagine water supply bores

Bore	Screened Interval (m BGS)	Aquifer	Use
6/92	29 to 89	MCFA	Drinking Water
7/92	29 to 89	MCFA	Drinking Water
Town Well	5 to 11	Alluvial	Irrigation

5.1.3 Groundwater levels

Groundwater levels generally follow topography and surface catchments throughout the area (Figure 3-1). A noted increase in water levels around the Beatons Creek reservoir and resultant deflection of groundwater contours indicate that water from the southern portion of the Project site flows in a southerly direction towards Nullagine, while groundwater from the northern portion of the Project site flows easterly towards the Nullagine River.

Potential seepage from the WRD would be directed towards the Nullagine water supply bores; however, water quality and stable isotope data suggest that there is no hydraulic connection between the Nullagine water supply bores and the proposed mine area. In addition, significant hydraulic barriers, in the form of the Beatons Creek Dam and the major fault located east of the dam, prevent flow from the site towards the water supply bores.

5.1.4 Water chemistry

Sampling and analysis of groundwater and surface water in the project area highlighted different signatures for the Beatons Creek bores, the Nullagine drinking water supply bores and the Town Well. Stable isotope signatures for the Beatons Creek and the Town Well and indicate different sources of water from that of NB6/92 and NB7/92. Based on the available chemistry and stable isotope data, the potential for impact from seepage from the Beatons Creek area to impact the Nullagine drinking water supply bores is negligible.

Stable isotope signatures did suggest that there is interaction with flowing surface water and the Town Well, although no direct connection can be inferred from the data. As a result, potential exists for surface water from the proposed mining activities to have impact the Town Well. This risk has been mitigated through the incorporation of containment structures into the conceptual WRD designs. Surface water from other mine activities should also be contained. Water containment structures are situated in locations where the MCFA outcrops, and seepage, if any, from these structures will infiltrate into the MCFA directly and have no impact on the Town Well.

5.1.5 Time of travel calculations

Time of Travel (TOT) for groundwater can be used as a preliminary method for determining the potential impacts from a propose activity on a receptor; the longer the time of travel the more opportunity for attenuation of any potential contaminants through ion-exchange, dilution and diffusion.

Water quality and stable isotope data suggest that there is no hydraulic connection between the Nullagine water supply bores and the proposed mine area. However, to further assess the likelihood of potential seepage from the Beatons Creek Project impacting the Nullagine drinking water supply bores, preliminary calculations have been completed to estimate the time of travel for water in the MCFA from the Project site to the water supply bores.

TOT calculations assume that the aquifer is homogenous, isotropic and infinite in extent and do not account for attenuation of contaminants through diffusion or dilution during transport. They are based on saturated flow through an aquifer and do not account for flow within the unsaturated zone. TOT calculations are derived from Darcy's Law for saturated flow in an aquifer, where the TOT can be expressed as:

Time (days) = Distance (m)/Darcy Velocity (m/day)

Where:

Distance (m) = The straight-line distance between the source and the receptor

Darcy velocity (m/day) = (Hydraulic conductivity (K) of the aquifer in m/day X the hydraulic of the aquifer gradient (i) in m/m)

Distances are approximate based on straight line distances derived within a GIS environment, measured from the downgradient portion of the Beatons Creek property to the receptors. Hydraulic gradient was estimated from water levels collected on the Beatons Creek site, and at 370 m AHD for the Town bore, NB6/92 and NB7/92. Higher hydraulic conductivity values, derived from the pumping test from DS01 were used to account for the possibility of fracture flow between the site and the bores. Results of the time of travel calculations are provided in Table 5-2, and suggest extended travel times between the Project site and the Nullagine drinking water supply bores.

Table 5-2: Time of travel calculations

Receptor	Distance (m)	Hydraulic gradient (m/m)	K (m/day)	Darcy velocity (m/day)	Time of Travel (days)	Time of Travel (years)
Town Bore	2000	0.012	0.32	1.25×10^{-2}	533,333	1,462
NB6/92	8000	0.003	0.32	9.38×10^{-4}	8,533,333	23,379
NB7/92	8000	0.003	0.32	9.38×10^{-4}	8,533,333	23,379

The TOT calculations can be considered conservative in that they have been developed using a relatively high hydraulic conductivity value, i.e. values derived from the pumped production bores which represent the most transmissive of all bores drilled on the site - and can therefore by considered to be conservative with respect to protection of the receptors.

The high salinities, low estimated hydraulic conductivities support and stable isotope signatures for samples from the monitoring bores also support extremely long residence times in the MCFA.

5.1.6 Assessment of potential impact on the Nullagine water supply bores

The available hydrogeological data support a conclusion that there will be no impact on the Nullagine drinking water supply bores from the proposed mining activities:

- Evidence collected as part of the hydrogeological investigation indicate that there is no connectivity between the groundwater system at the Beatons Creek site and the Nullagine water supply bores. In addition, there are two hydrualic barriers identified between the Project site and the water supply bores, namely the Beatons Creek Dam and a large, high permeability NNE-striking fault located east of the dam.

- Composition of groundwater from the Nullagine Town Water bores differs from that from bores at Beatons Creek, suggesting that they are exploiting different groundwater systems with negligible interconnectivity.
- Stable isotope signatures from the Nullagine water supply bores plot outside the range of the Beatons Creek bores, suggesting that they are exploiting different water sources.
- Results of the time of travel calculations suggest extended (i.e. >20,000 years) travel times between the Project site and the Nullagine drinking water supply bores.
- A geochemical assessment of the material to be mined at the Beatons Creek Project has indicated that the waste rock contains limited sources of acidity, which resulted in low paste pH and negative acid neutralising capacity (ANC).
- As an additional mitigative measure, all identified PAF waste will be encapsulated in designated cells, and capped with low permeability clays to prevent seepage through the PAF material.
- The available hydrogeological data support a conclusion that there will be no impact on the Town Well:
- The stable isotope signature from the Town Well is distinct from the Beatons Creek bores, suggesting that they are exploiting different water sources.
- The stable isotope signatures suggest that alluvial aquifer of the Nullagine River is not connected to the MCFA or HFGS in the Project area.
- This risk of surface water from mine activities impacting the Town Well has been mitigated through the incorporation of containment structures, seepage, if any, from these structures will infiltrate directly into the MCFA and have no impact on the Town Well.

In summary, the waste material has limited sources of acidity and low PAF; and the groundwater level, quality and hydraulic data support a conclusion that there will be no impact on the Nullagine drinking water supply bores from the proposed mining activities or the TSF.

5.2 Groundwater Dependent Ecosystems

There are no identified GDEs within 5 km of the Beatons Creek Project site. The closest potential GDEs are riparian environments associated with the ephemeral Nullagine River. As there no drawdown impacts and no GDEs identified on the Project site, no impacts on GDEs are anticipated from the proposed mining activities.

5.3 Stygofauna and Troglofauna

Consideration of potential impacts on subterranean fauna in Western Australia is completed using a risk-based assessment as outlined by the Environmental Protection Authority (2013). This process considers the likely presence of habitat, and the potential for impacts on that habitat from the proposed mining activities and based on those factors outlines the appropriate level of investigation to assess and potential impacts. As part of this assessment, the following salient points were considered:

- The mining activity is within fractured rock.
- No groundwater abstraction or reinjection, and therefore drawdown/increase of water levels in the aquifer, are proposed for the Project site.
- No salinisation is anticipated as the mined material is allocated above the water table.
- Low AMD risk associated with the waste material suggest negligible impact on local groundwater quality.

Based on these facts, a desktop assessment was considered appropriate to evaluate the risk associated with the proposed mining activity.

A desktop assessment of potential stygofauna was completed by Pendragon. Initial results suggest that any stygofauna present on the Project site will be within the regionally extensive MCFA. Work on the MCFA carried out by Rapallo Consulting and Contracting Engineers (Rapallo) in 2006 and 2007 with details provided by George et al. (2007) suggest that the MCFA is regionally interconnected, therefore, it appears unlikely that Stygofauna collected from this area are restricted in distribution (George et al., 2007). This was further supported by sampling programs completed for Millennium Minerals Ltd within the MCFA (Ecologia, 2010; 2011). These concluded that both the stygofauna and troglofauna populations in the area are part of a regional system within an interconnected aquifer, and that no significant impacts on stygofauna or troglofauna would be anticipated from mining activities within the MCFA.

Therefore, the EPA's objective of maintaining representation, viability and ecological function at the species, populations and assemblage level is considered compatible with the proposed Beatons Creek Mining Proposal.

6 Groundwater monitoring and management

6.1 Groundwater management objectives

Key aspects of groundwater management relevant to project operations are identified in Table 6-1. This table outlines the objectives and review mechanisms that will be employed to evaluate the mine operation and its potential impacts to water quality throughout the life of mine. The primary mechanism for management of groundwater will be through an ongoing monitoring program.

Table 6-1: Water management plan aspects & objectives

Aspect	Aim for the Period Covered	Review Mechanisms
Groundwater Levels	Monitor impacts to groundwater system at the Beatons Creek project by monitoring groundwater levels	Monthly review and verification of monitoring results by Novo
Water Quality	Monitor potential changes to groundwater quality at Beatons Creek and on the Nullagine Public Drinking Water Supply by undertaking periodic monitoring of groundwater quality	Quarterly review and verification of monitoring results by Novo, including trend analysis to flag any future issues Annual environmental review reporting.
Water Use Efficiency	Track onsite water use and water use efficiency against internal targets Track the implementation of water management incentives for water use efficiency	Novo internal review program

6.2 Monitoring program

The proposed monitoring and analytical program, outlined in Table 6-2, has been designed to monitor aquifer water quality before operations commence and throughout the mine life. This program is designed to allow implementation of contingency plans should aquifer and/or bore performance differ from predicted performance.

Monitoring bores have been selected based on location, aquifer, potential impact and specific activities. The rationale for monitoring bore selections is included in Table 6-2 for all monitoring bores. Existing and proposed monitoring bores are presented in Figure 3-2.

The monitoring site locations, parameters and frequency of testing have been developed based on the nature of the proposed operation, as well as the existing hydrogeological conditions and the objectives of the DWER Groundwater Quality Protection Guidelines (DWER, various documents; NH&MRC, 2004; ANZECC, 2000). In addition, they were developed to meet monitoring requirements and the location of the Project within the Nullagine Public Drinking Water Source Area protection zone. The schedule and details for the proposed groundwater quality sampling program for monitoring and production bores are provided in Table 6-2. A list of recommended parameters for analysis and respective limits of reporting are provided for the bores, based on their monitoring rationales in Table 6-3 and Table 6-4. Reporting procedures including documents to be submitted to regulatory agencies (including DWER) are planned as follows:

- Groundwater levels – Assessments of groundwater levels will be undertaken annually and incorporated into the annual groundwater monitoring report. This assessment is designed to identify potential impacts interpreted from water level variability.
- Groundwater quality – An annual groundwater monitoring report will be submitted as part of the multi-agency Annual Environmental Report.

- Event-based incident reporting – Where an incident (e.g. spill) occurs that has the potential to impact surface or groundwater, notification will be given to the DWER and DMIRS as soon as possible.
- Water quality exceedances – Any exceedance indicated by water monitoring will be reported and discussed with DWER and DMIRS as soon as apparent and possible.

Table 6-2: Recommended monitoring frequency and analytical suites for monitoring bores

<table>
<tr><th>Bore ID</th><th>Rationale</th><th>Status</th><th>Suite</th><th>Frequency</th></tr>
<tr><td>NRB03</td><td>Upstream of Operations/ Background Monitoring</td><td rowspan="13">Drilled and constructed</td><td rowspan="14">Baseline and water levels</td><td rowspan="15">Quarterly</td></tr>
<tr><td>NRB06</td><td>Upstream of Operations/ Background Monitoring</td></tr>
<tr><td>NRB10</td><td>Upstream of Operations/ Background Monitoring</td></tr>
<tr><td>DS04B</td><td>Upstream of Operations/ Background Monitoring</td></tr>
<tr><td>DS02A</td><td>Downstream of Operations/ Background Monitoring</td></tr>
<tr><td>NRB13</td><td>Downstream of Operations</td></tr>
<tr><td>NRB09</td><td>Downstream of Operations, upstream of Nullagine water supply bores</td></tr>
<tr><td>WRDMB01</td><td>Grants Hill WRD Monitoring</td></tr>
<tr><td>WRDMB02</td><td>Grants Hill WRD Monitoring</td></tr>
<tr><td>WRDMB03</td><td>Grants Hill WRD Monitoring</td></tr>
<tr><td>WRDMB04</td><td>Edwards WRD Monitoring</td></tr>
<tr><td>WRDMB06</td><td>Edwards WRD Monitoring</td></tr>
<tr><td>WRDMB07</td><td>Downstream of Operations, upstream of Nullagine water supply bores</td></tr>
<tr><td>WEDMB08</td><td>Downstream of Operations</td></tr>
<tr><td>WRDMB05</td><td>Edwards WRD Monitoring</td><td>Drilled but not constructed (no water intersected)</td></tr>
<tr><td>NRB08</td><td>Downstream Sediment Pond - Fractured Rock Aquifer</td><td>Drilled and constructed</td><td>Sediment Pond and water levels</td></tr>
</table>

Table 6-3: Baseline suite of parameters for analysis

Suite 1: Baseline	
Analysis	**Parameter (recommended limit of reporting in mg/L)**
General Chemistry	pH, Electrical Conductivity, TDS, ORP, acidity if pH<6.0 or alkalinity if pH >6.0, hardness
Major ions	Ca (1), K (1), Mg (1), Na (1), Cl (1), F (1) and SO_4 (1).
Total and Dissolved metals	Al (0.001), As (0.0001), B (0.001), Ba (0.001), Be (0.001), Cd (0.0001), Co (0.001), Cr total (0.001), Cr VI (0.001), Cu (0.001), Fe (0.01), Hg (0.0001), Mn (0.001), Mo (0.001), Ni (0.001), Pb (0.001), Sb (0.001), Se (0.0005), Sn (0.001), Sr (0.001), Ti (0.001), Zn (0.001)
Nutrients (explosive – TSF tracers)	NO_2 as N (<0.005), NO_3 (<0.05), NH_3 as N (<0.05)
Hydrocarbons	Oil and Grease (recoverable hydrocarbons)

Table 6-4: Sediment pond suite of parameters for analysis

Suite 2: Sediment Pond	
Analysis	**Parameter (recommended limit of reporting in mg/L)**
General Chemistry	pH, Electrical Conductivity, TDS, ORP, acidity if pH<6.0 or alkalinity if pH >6.0, hardness
Major ions	Ca (1), K (1), Mg (1), Na (1), Cl (1), SO_4 (1) and Fe
Total and Dissolved metals	Al (0.001), As (0.0001), B (0.001), Ba (0.001), Be (0.001), Cd (0.0001), Co (0.001), Cr total (0.001), Cr VI (0.001), Cu (0.001), Fe (0.01), Hg (0.0001), Mn (0.001), Mo (0.001), Ni (0.001), Pb (0.001), Sb (0.001), Se (0.0005), Sn (0.001), Sr (0.001), Ti (0.001), Zn (0.001)
Nutrients (explosive – TSF tracers)	NO_2 as N (<0.005), NO3 (<0.05), NH_3 as N (<0.05)
Hydrocarbons	Total Petroleum Hydrocarbons, Total Recoverable Hydrocarbons, BTEXN, TPH(V)/BTEX Surrogates
Others	Ferrous Iron

6.3 Monitoring protocol

Samples will be collected in accordance with standard protocol and sent for analysis to an accredited external laboratory.

6.4 Summary of commitments

Novo commits to complying with the following conditions and responsibilities:

- A comprehensive monitoring program is planned to track groundwater levels, and water quality.
- Monitoring data will be submitted as part of the multi-agency Annual Environmental Report annually and will be prepared by a groundwater professional in accordance with the DWER publication *Hydrogeological and Groundwater Monitoring Report Guidelines*.
- Should the monitoring at any time indicate a need for prompt action to prevent or reduce the effect of Novo's activities on the aquifer, Novo will immediately report this to the DWER to develop corrective measures.

Novo will comply with the proposed monitoring program and required improvements over time as directed by the DWER.

6.5 Responsible parties

The Environmental Manager for the Beatons Creek Gold Project will be responsible for maintaining compliance with the monitoring program and will be the primary contact for all water related matters.

For enquiries contact:

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The analyses, calculations conclusions and recommendations contained in this report are based on data provided by Novo and derived from a limited number of test holes obtained from widely spaced subsurface explorations. The methods used indicate subsurface conditions only at the specific locations, only at the time they were obtained, and only to the depths penetrated. The data cannot be relied on to accurately reflect the nature and extent of strata variations that usually exist between sampling or testing locations.

Compiled by

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Peer Reviewed by

Zbigniew Boniecki

Senior Consultant.

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Appendices

Appendix A: Results of Hydrogeological Exploration Program (KCB, 2015)

October 30, 2015

Novo Resources Corporation
673 Murray Street
West Perth WA 6005

Simon Pooley
Study Manager

Dear Mr. Pooley:

Beatons Hydrogeological Exploration Drilling Results

Please find attached a draft of the Drilling Results report for the Beatons Creek project for your review. Please provide comments at your earliest convenience.

If you have any questions or concerns, please do not hesitate to contact me directly at any of the numbers below.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Kevin Vermaak
Hydrogeologist

KHV:KHV

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Appendix I - Drill Logs

1 INTRODUCTION

Novo Resources Corporation (NRC) contracted Klohn Crippen Berger Ltd (KCB) to undertake hydrogeological exploration drilling at the Beatons Creek Project Site. The drilling program was initiated by NRC in order to develop a water supply for proposed mining activities.

1.1 Scope of Service

In order to address the defined objectives for this assessment the following scope of service was proposed:

- Hydrogeological exploration drilling to identify locations for additional production bores for the Project; and,
- Supervision of the drilling.

1.2 Drilling

A hydrogeological exploration drilling and production bore construction program was conducted during October of 2015. Eleven (11) hydrogeological exploration bores were drilled of which one was identified to be converted to a production bore at a later stage.

2 HYDROGEOLOGICAL EXPLORATION DRILLING

2.1 Methodology

Initial exploratory holes were completed in order to assess the hydrogeological characteristics of the targets, and to determine if the holes would be suitable for production bores. Exploratory holes were completed using 5.5” (139.7 mm) reverse circulation drilling methods.

NRC contracted NDRC Drilling in October 2015 to undertake the hydrogeological exploration drilling program. Hydrogeological observation was conducted by a KCB representative, including monitoring of drilling progress, logging of drill samples, recommendations for future casing installation, selection of drilling depths, and monitoring safe work practices.

2.2 Development & Field Water Quality Measurements

Hydrogeological (incl. physiochemical) field parameters were measured and air-lift yields monitored periodically throughout the drilling process to inform the decision to construct a production bore or to continue with the hydrogeological exploration drilling program and mobilise to the next drill location.

Where significant airlift yield were encountered, the bores were subjected to continuous air lifting (termed “development”) until the bore was cleared of any excess fines and drilling additives. During this process, preliminary long-term yield estimates were undertaken and physiochemical parameters measured.

2.3 Results

Exploration drilling was completed at eleven (11) locations proposed for production bores, of which one selected for conversion to production bores at a later stage

A summary of the hydrogeological exploration drilling results and the production bore construction are shown in Table 2-1, with drilling locations illustrated in Figure 1.The drilling logs are presented in Appendix I.

Table 2-1 Summary of Hydrogeological Drilling

Bore ID	Location		Status	Current Depth	Water Strike Depths	Final Airlift Yield	pH	EC (uS/cm)	Comment
	X	Y							
BC1	196776	7580811	Complete	102	28	0.1	NA	NA	NA
BC2	197237	7581367	Complete	96	63	1.6	8.1	10518	NA
BC3	198398	7582656	Complete	108	64,92	2	8.53	3582	Water appears stagnant
BC4	198475	7584606	Complete	126	none	0	NA	NA	NA
BC4A	198475	7584606	Complete	84	none	0	NA	NA	NA
BC5	198977	7585371	Complete	56	26, 50	0.8	NA	NA	NA
BC6	199791	7574625	Complete	102	44	0.5	8.13	836	NA
BC7	199933	7574797	Complete	112	22,40-99	1.9	8.46	2379	Consider reaming to larger diameter
BC9	208937	7578732	Complete	96	none	0	NA	NA	NA
BC10	207978	7579075	Complete	96	25,70	1.1	NA	NA	NA
BC11	207414	7579694	Complete	96	51	0.1	NA	NA	NA

2.4 Recommendations

2.4.1 BC7

Numerous water strikes were encountered during the drilling of BC7 with the majority of the strikes occurring between 40 and 90 meters below ground level. The geology presented as highly fractured with numerous quartz veins and weathered zones. It is recommended that the bore is reamed to 8" diameter and constructed at 6" diameter, using a combination of slotted and blank Class 12 PVC casing and the annulus filled with screened gravel. The screened section should start from approximately 22 meters below the surface to the final depth of the bore.

A 24 hour test pumping program should be conducted in order to estimate a long term abstraction rate.

2.4.2 Alternative Water Sources

Existing Department of Public Works Bore

The Department of Public Works (DPW) drilled numerous bores in the vicinity of Nullagine in order to establish a drinking water supply. Bore B1192 produced a final airlift yield of approximately 7L/s and was not used due to inferior water quality. Drilling details recorded for this bore can be seen in Appendix II and its location is presented in Table 2-2. A pump test should be conducted at this location to assess its potential as a water supply production bore.

Table 2-2 Location details of DPW bore

Bore ID	Location	
	X	Y
B1192	199003	7573637

Alternative Groundwater Sources

In order to secure a reliable water supply for the project, alternative potential water source areas will need to be identified and further hydrogeological exploration drilling conducted. Possible future areas include:

- Blue Spec mine area;
- previous Blue Spec supply facilities;
- the area west of water reserve boundary; and,
- southern tenements.

In order to more accurately site future bore locations the use of geophysical techniques is recommended, possibly ground magnetics or EM34 surveys.

2.4.3 Improved Water Harvesting Techniques

Improved water harvesting/recycling techniques will be essential during the production phase of the Project. A thorough investigation should be completed in order to identify techniques that will enable more efficient use and recycling of water during production.

3 CLOSING

This report was prepared by Klohn Crippen Berger Ltd. for Novo Resources Limted. The material in it reflects Klohn Crippen Berger's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Klohn Crippen Berger Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

KLOHN CRIPPEN BERGER LTD.

Kevin Vermaak
Hydrogeologist

KHV: KHV

FIGURES

Figure 1 Hydrogeological Exploration Drilling Targets - October 2015

Appendix B: Water Quality Analytical Results

*Green cells are still being sampled					LocCode	B1192	BCRC12-69	BCRC13-30	BSS	CGC001	CGC002	DAM 1	DAM 2	DC001	DS01	DS02A	DS02A	DS02A	DS02A	DS02A	DS02A	DS02B	DS03A	DS04A
					Sampled_Date-Time	18/11/2015	18/07/2015	10/06/2015	18/11/2015	21/04/2015	22/04/2015	13/06/2015	13/06/2015	21/04/2015	13/06/2015	18/07/2015	6/11/2017	29/11/2017	08/02/2018	16/05/2018	13/06/2018	13/06/2015	13/06/2015	6/11/2017
				ADWG 2015 Aesthetic	ADWG 2015 Health																			
ChemName		**Units**	**EQL**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Anions Total	1	meq/L	0.01			14.2	-	-	35	9	21.7	-	-	0.02	-	-	50.2	47.5	50.9	52.6	47.7	-	-	39.3
Cations Total	2	meq/L	0.01			13.3	-	-	36	9.62	17.8	-	-	1.01	-	-	48.6	46.2	46.7	60	50.1	-	-	38.6
Ionic Balance	3	%	0.01			3.31	-	-	1.33	3.29	9.96	-	-	-	-	-	1.59	1.35	4.26	6.55	2.4	-	-	0.86
Electrical conductivity *(lab)	4	µS/cm	1			1320	5500	1660	2820	-	-	952	1880	-	3280	3500	3570	3620	3610	-		3960	3160	2970
pH (Lab)	5	pH_Units	0.01			-	4.57	7.73	-	-	-	8.23	8.7	-	7.51	7.68	7.97	7.82	7.58	7.74	7.49	7.31	7.69	7.85
TDS	6	mg/L	10	600		-	6070	1250	-	-	-	688	1390	-	2520	2560	3250	3100	2980	3320	3090	3040	2540	2650
TSS	7	mg/L	1			-	<5	-	-	5	4	-	-	19	-	<5	-	-	-	-		-	-	-
Hardness as CaCO3	8	mg/L	1	200		289	3350	405	1370	418	795	404	839	35	1440	1590	1750	1670	1710	2060	1820	1520	1460	1230
Acidity (as CaCO3)	9	mg/L	1			-	393	4	-	155	378	<1	<1	8	9	33	53	33	43	-		8	8	54
Alkalinity (Hydroxide) as CaCO3	10	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1000	<1	<1	<1
Alkalinity (total) as CaCO3	11	mg/L	1			386	<1	149	254	<1	<1	208	129	1	207	536	475	447	426	450	378	280	218	295
Bicarbonate	12	mg/L	1			386	-	-	254	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Alkalinity (Bicarbonate as CaCO3)	13	mg/L	1			-	<1	149	-	<1	<1	208	101	1	207	536	475	447	426	450	378	280	218	295
Alkalinity (Bicarbonate)	14	mg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	549	461.2	-	-	-
Alkalinity (Carbonate as CaCO3)	15	mg/L	1			-	<1	<1	-	<1	<1	<1	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate	16	mg/L	1			<1	-	-	<1	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Chloride	17	mg/L	1	250		179	308	96	146	32	64	76	168	<1	333	400	396	378	372	468	442	400	340	312
Fluoride	18	mg/L	0.1			-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.3	1	-	-	-
Silicon as SiO2 (Filtered)	19	mg/L	0.1			-	34.7	14.5	-	-	-	4	7.4	-	14.6	59.6	-	-	-	-		21.7	15.4	-
Sulphate (Filtered)	20	mg/L	1	250		71	3980	623	1240	389	954	223	718	<1	1290	1190	-	1340	-	1460	1330	1540	1260	-
Sulphate	21	mg/L				-	-	-	-	-	-	-	-	-	-	-	1420	-	1530	-		-	-	1180
Calcium (Filtered)	22	mg/L	1			63	83	70	153	9	15	25	69	4	92	102	110	104	108	91	109	140	70	27
Magnesium (Filtered)	23	mg/L	1			32	764	56	240	96	184	83	162	6	293	324	359	343	350	445	375	284	312	282
Potassium (Filtered)	24	mg/L	1			13	14	15	24	2	3	8	9	2	11	8	7	6	6	7	9	15	10	3
Sodium (Filtered)	25	mg/L	1	180		166	213	212	183	28	41	54	119	6	263	296	309	291	284	428	311	390	232	321
Ammonia as N	26	mg/L	0.01			-	0.06	0.35	-	0.08	0.03	0.03	0.03	0.03	0.03	0.04	0.1	0.15	0.10	0.05	80	0.03	0.03	0.03
Kjeldahl Nitrogen Total	27	mg/L	0.1			-	0.5	0.4	-	0.3	0.3	1.3	0.7	0.3	0.2	0.3	-	-	-	-		0.3	0.2	-
Nitrate (as N)	28	mg/L	0.01			-	<0.01	<0.01	-	0.84	0.48	<0.01	0.01	0.76	<0.01	<0.01	0.02	0.03	<0.01	0.06	<0.01	<0.01	<0.01	<0.01
Nitrite (as N)	29	mg/L	0.01			-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total)	30	mg/L	0.1			-	0.5	0.4	-	1.1	0.8	1.3	0.7	1.1	0.2	0.3	-	-	-	-		0.3	0.2	-
Phosphorus	31	mg/L	0.01			-	0.29	0.05	-	<0.01	0.01	0.02	<0.01	0.03	<0.01	0.05	-	-	-	-		0.03	<0.01	-
Reactive Phosphorus as P	32	mg/L	0.01			-	0.01	<0.01	-	-	-	<0.01	<0.01	-	<0.01	0.01	0.02	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02
Oil and Grease	33	mg/L				-	-	-	-	-	-	-	-	-	-	-	<5	<5	<5	-		-	-	<5
C6 - C9	34	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<20	<20	-	-	-
C6-C10	35	mg/L	0.02			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-
C10 - C14	36	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	<50	-	-	-
C15 - C28	37	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-
C29-C36	38	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	<50	-	-	-
+C10 - C36 (Sum of total)	39	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	<50	-	-	-
>C10 - C16 Fraction	40	µg/L	100			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-
>C16 - C34 Fraction	41	µg/L	100			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-
>C34 - C40 Fraction	42	µg/L	100			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-
C10 - C40 (Sum of total)	43	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-
Naphthalene	44	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-
Total BTEX	45	mg/L	0.001			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001	-	-	-
F2-Napth (C10-C16)	46	mg/L	0.1			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	-	-	-
F1 minus BTEX (C6-C10)	47	mg/L	0.02			-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-
Benzene	48	µg/L			1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-
Ethylbenzene	49	µg/L		3	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-
Toluene	50	µg/L		25	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-
Xylene (m & p)	51	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-
Xylene (o)	52	µg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-
Xylene Total	53	µg/L		20	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-
pH (Field)	54	pH_Units	0.01			7.85	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Nitrite + Nitrate as N	55	mg/L	0.01			-	<0.01	<0.01	-	0.84	0.48	<0.01	0.01	0.76	<0.01	<0.01	0.02	0.03	<0.01	0.06		<0.01	<0.01	<0.01
Nitrate + Nitrite (as N)	56	mg/L	0.01			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-
Ferrous Iron	57	mg/L	0.05			-	111	-	-	-	-	-	-	-	-	2.91	-	-	-	-	-	-	-	-
Ferrous Iron (Filtered)	58	mg/L				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Aluminium	59	mg/L	0.01			0.02	-	-	0.02	-	-	-	-	-	-	-	0.029	<0.01	0.04	0.009	0.027	-	-	0.029
Aluminium (Filtered)	60	mg/L	0.01			-	8.44	<0.01	-	10.4	32.5	0.01	<0.01	0.54	0.01	<0.01	<0.005	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	<0.005
Antimony	61	mg/L			0.003	-	-	-	-	-	-	-	-	-	-	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	-	<0.0002
Antimony (Filtered)	62	mg/L			0.003	-	-	-	-	-	-	-	-	-	-	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	-	<0.0002
Arsenic	63	mg/L	0.001		0.01	<0.001	-	-	4.95	-	-	-	-	-	-	-	0.002	<0.001	0.003	0.0008	0.0017	-	-	0.0316
Arsenic (Filtered)	64	mg/L	0.001		0.01	-	0.017	0.013	-	<0.001	<0.001	0.005	0.002	<0.001	<0.001	0.005	0.0007	<0.001	0.001	0.0008	0.0015	0.002	<0.001	0.0032
Barium	65	mg/L			2	-	-	-	-	-	-	-	-	-	-	-	0.0237	0.021	0.021	0.0192	0.0291	-	-	0.0277
Barium (Filtered)	66	mg/L			2	-	-	-	-	-	-	-	-	-	-	-	0.0211	0.02	0.025	0.0169	0.0275	-	-	0.0266
Beryllium	67	mg/L			0.06	-	-	-	-	-	-	-	-	-	-	-	<0.0001	<0.001	<0.001	<0.0001	<0.0001	-	-	<0.0001
Beryllium (Filtered)	68	mg/L			0.06	-	-	-	-	-	-	-	-	-	-	-	<0.0001	<0.001	<0.001	<0.0001	<0.0001	-	-	<0.0001
Boron	69	mg/L			4	-	-	-	-	-	-	-	-	-	-	-	0.632	0.59	3.50	0.87	0.766	-	-	0.708
Boron (Filtered)	70	mg/L			4	-	-	-	-	-	-	-	-	-	-	-	0.567	0.62	0.76	0.854	0.742	-	-	0.597
Cadmium	71	mg/L	0.0001		0.002	<0.0001	-	-	<0.0001	-	-	-	-	-	-	-	<0.00005	<0.0001	<0.0001	<0.00005	<0.00005	-	-	0.00007
Cadmium (Filtered)	72	mg/L	0.0001		0.002	-	0.0154	<0.0001	-	0.0019	0.0037	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.00005	<0.0001	<0.0001	<0.00005	<0.00005	<0.0001	<0.0001	0.00005
Chromium (hexavalent)	73	mg/L			0.05	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	<0.001	<0.001	-	-	-
Chromium (hexavalent) (Filtered)	74	mg/L			0.05	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.001	<0.001	-	-	<0.01

*Green cells are still being sampled					LocCode	B1192	BCRC12-69	BCRC13-30	BSS	CGC001	CGC002	DAM 1	DAM 2	DC001	DS01	DS02A	DS02A	DS02A	DS02A	DS02A	DS02A	DS02B	DS03A	DS04A
					Sampled_Date-Time	18/11/2015	18/07/2015	10/06/2015	18/11/2015	21/04/2015	22/04/2015	13/06/2015	13/06/2015	21/04/2015	13/06/2015	18/07/2015	6/11/2017	29/11/2017	08/02/2018	16/05/2018	13/06/2018	13/06/2015	13/06/2015	6/11/2017
				ADWG 2015 Aesthetic	ADWG 2015 Health																			
ChemName		**Units**	**EQL**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Chromium (III+VI)	75	mg/L	0.001			0.001	-	-	0.002	-	-	-	-	-	-	-	<0.0002	<0.001	<0.001	0.0006	0.0131	-	-	0.0002
Chromium (III+VI) (Filtered)	76	mg/L	0.001			-	<0.001	<0.001	-	0.002	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.001	<0.001	0.0005	0.0002	<0.001	<0.001	<0.0002
Cobalt	77	mg/L				-	-	-	-	-	-	-	-	-	-	-	0.0008	<0.001	0.010	0.0017	0.002	-	-	0.0063
Cobalt (Filtered)	78	mg/L	0.001			-	-	-	-	0.404	0.835	-	-	0.019	-	-	0.001	<0.001	0.001	0.0014	0.0016	-	-	0.0056
Copper	79	mg/L	0.001	1	2	0.004	-	-	0.004	-	-	-	-	-	-	-	<0.0005	<0.001	0.003	<0.0005	0.0007	-	-	0.0006
Copper (Filtered)	80	mg/L	0.001	1	2	-	0.042	0.002	-	0.108	0.312	<0.001	0.002	0.026	0.003	0.002	0.0014	<0.001	<0.001	<0.0005	<0.0005	0.003	0.003	0.005
Iron	81	mg/L	0.05	0.3		0.05	110	11.4	10.7	-	-	0.16	0.11	-	0.11	3	5.95	1.3	8.92	0.572	1.95	7.51	0.34	3.5
Iron (Filtered)	82	mg/L	0.05	0.3		-	109	<0.05	-	<0.05	0.41	<0.05	<0.05	0.08	<0.05	<0.05	0.621	0.07	1.30	0.468	1.34	<0.05	0.08	0.01
Lead	83	mg/L	0.001		0.01	<0.001	-	-	<0.001	-	-	-	-	-	-	-	<0.0001	<0.001	<0.001	<0.0001	<0.0001	-	-	0.0003
Lead (Filtered)	84	mg/L	0.001		0.01	-	0.018	<0.001	-	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	0.0002
Manganese	85	mg/L		0.1	0.5	-	-	-	-	-	-	-	-	-	-	-	0.516	0.456	0.748	0.305	0.564	-	-	0.271
Manganese (Filtered)	86	mg/L	0.001	0.1	0.5	-	12.6	0.72	-	1.32	2.36	<0.001	0.004	0.09	0.534	2.73	0.504	0.458	0.600	0.26	0.545	2.66	0.463	0.26
Mercury	87	mg/L	0.0001		0.001	<0.0001	-	-	<0.0001	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Mercury (Filtered)	88	mg/L	0.0001		0.001	-	<0.0001	<0.0001	-	-	-	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	89	mg/L			0.05	-	-	-	-	-	-	-	-	-	-	-	0.0021	0.002	0.001	0.0036	0.0047	-	-	0.0062
Molybdenum (Filtered)	90	mg/L			0.05	-	-	-	-	-	-	-	-	-	-	-	0.0017	0.002	0.002	0.0033	0.0024	-	-	0.0048
Nickel	91	mg/L	0.001		0.02	0.002	-	-	0.005	-	-	-	-	-	-	-	0.0014	<0.001	0.035	0.0017	0.0123	-	-	0.0125
Nickel (Filtered)	92	mg/L	0.001		0.02	-	7.2	0.01	-	1.22	2.55	0.014	0.007	0.058	0.012	0.001	0.0015	<0.001	0.002	0.0014	0.0031	0.001	0.03	0.0138
Selenium	93	mg/L	0.01		0.01	<0.01	-	-	<0.01	-	-	-	-	-	-	-	0.0002	<0.01	<0.01	<0.0002	<0.0002	-	-	0.0004
Selenium (Filtered)	94	mg/L	0.01		0.01	-	<0.01	<0.01	-	-	-	<0.01	<0.01	-	<0.01	<0.01	<0.0002	<0.01	<0.01	<0.0002	<0.0002	<0.01	<0.01	0.0005
Silver	96	mg/L	0.00001			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-

***Green cells are still being sampled**

					LocCode	DS04A	DS04B	DS04B	DS04B	DS04B	LP001	LP002	NRB01	NRB02	NRB03	NRB03	NRB03	NRB03	NRB03	NRB03	NRB04	NRB05	NRB05	NRB06
					Sampled_Date-Time	29/11/2017	18/07/2015	08/02/2018	16/05/2018	13/06/2018	22/04/2015	22/04/2015	14/06/2015	18/07/2015	13/06/2015	7/11/2017	29/11/2017	07/02/2018	15/05/2018	12/06/2018	18/07/2015	14/06/2015	07/02/2018	14/06/2015
				ADWG 2015 Aesthetic	ADWG 2015 Health																			
ChemName		**Units**	**EQL**			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Anions Total	1	meq/L	0.01			38.5	-	40.5	41.9	44.8	10.6	8.68	-	-	-	6.28	6.04	6.37	5.93	6.58	-	-	37.3	-
Cations Total	2	meq/L	0.01			39	-	41.0	50.5	45	10.6	7.89	-	-	-	6.07	5.95	6.11	6.11	6.87	-	-	34.1	-
Ionic Balance	3	%	0.01			0.6	-	0.64	9.32	0.18	0.12	4.78	-	-	-	1.73	0.77	2.07	1.5	2.14	-	-	4.45	-
Electrical conductivity *(lab)	4	µS/cm	1			3100	3990	3290	-		-	-	1930	1780	592	627	655	618	-		466	2430	2750	2150
pH (Lab)	5	pH_Units	0.01			7.73	7.26	7.24	7.32	7	-	-	7.05	7.56	7.17	7.72	7.54	7.05	6.67	6.29	6.91	8.86	7.63	7
TDS	6	mg/L	10	600		2470	2910	2610	2700	2720	-	-	1490	1000	370	559	470	370	421	470	258	1860	2170	1690
TSS	7	mg/L	1			-	8	-	-		5	4	-	6	-	-	-	-	-		26	-	-	-
Hardness as CaCO3	8	mg/L	1	200		1260	1680	1360	1690	1510	404	300	973	744	206	173	171	177	170	191	130	1010	1310	817
Acidity (as CaCO3)	9	mg/L	1			38	23	35	-		52	10	15	50	6	7	21	20	-		27	<1	20	17
Alkalinity (Hydroxide) as CaCO3	10	mg/L	1			<1	<1	<1	<1	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1000	<1	<1	<1	<1
Alkalinity (total) as CaCO3	11	mg/L	1			312	316	310	294	297	26	1	142	646	133	66	70	65	53	52	119	26	250	187
Bicarbonate	12	mg/L	1			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Alkalinity (Bicarbonate as CaCO3)	13	mg/L	1			312	316	310	294	297	26	1	142	646	133	66	70	65	53	52	119	10	250	187
Alkalinity (Bicarbonate)	14	mg/L				-	-	-	358.7	362.3	-	-	-	-	-	-	-	-	64.66	63.44	-	-	-	-
Alkalinity (Carbonate as CaCO3)	15	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	16	<1	<1
Carbonate	16	mg/L	1			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Chloride	17	mg/L	1	250		304	433	324	348	376	66	56	140	247	57	83	79	80	82	97	50	313	326	172
Fluoride	18	mg/L	0.1			-	-	-	1.7	1.5	-	-	-	-	-	-	-	-	0.4	0.4	-	-	-	-
Silicon as SiO2 (Filtered)	19	mg/L	0.1			-	45.2	-	-		-	-	22.4	28.4	16.7	-	-	-	-		23	3.2	-	24
Sulphate (Filtered)	20	mg/L	1	250		1140	1580	-	1260	1360	393	340	834	112	108	-	116	-	123	135	59	959	-	904
Sulphate	21	mg/L				-	-	1210	-		-	-	-	-	-	126	-	135	-		-	-	1110	-
Calcium (Filtered)	22	mg/L	1			28	45	30	42	38	53	21	40	26	20	5	6	5	4	4	16	380	102	47
Magnesium (Filtered)	23	mg/L	1			288	381	311	386	344	66	60	212	165	38	39	38	40	39	44	22	14	256	170
Potassium (Filtered)	24	mg/L	1			3	6	3	6	6	3	3	7	8	4	<1	<1	<1	2	2	7	20	12	21
Sodium (Filtered)	25	mg/L	1	180		318	372	319	380	337	56	42	99	124	44	60	58	59	61	69	42	169	176	169
Ammonia as N	26	mg/L	0.01			0.1	0.05	0.03	0.03	30	0.01	0.03	0.06	0.07	0.05	0.02	0.02	0.03	0.01	20	0.04	0.16	0.39	<0.01
Kjeldahl Nitrogen Total	27	mg/L	0.1			-	0.2	-	-		0.2	0.2	0.3	0.3	0.3	-	-	-	-		0.3	0.3	-	0.2
Nitrate (as N)	28	mg/L	0.01			0.09	<0.01	<0.01	<0.01	0.01	0.2	0.43	<0.01	<0.01	0.01	1.54	1.61	1.74	1.82	2.34	0.01	<0.01	0.02	<0.01
Nitrite (as N)	29	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total)	30	mg/L	0.1			-	0.2	-	-		0.4	0.6	0.3	0.3	0.3	-	-	-	-		0.3	0.3	-	0.2
Phosphorus	31	mg/L	0.01			-	<0.01	-	-		<0.01	<0.01	0.01	0.05	<0.01	-	-	-	-		0.02	<0.01	-	0.01
Reactive Phosphorus as P	32	mg/L	0.01			0.01	0.1	<0.01	<0.01	0.02	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	33	mg/L				<5	-	<5	-		-	-	-	-	-	<5	<5	<5	-		-	-	<5	-
C6 - C9	34	µg/L				-	-	-	<20	<20	-	-	-	-	-	-	-	-	<20	<20	-	-	-	-
C6-C10	35	mg/L	0.02			-	-	-	<0.02	<0.02	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-
C10 - C14	36	µg/L				-	-	-	<50	<50	-	-	-	-	-	-	-	-	<50	<50	-	-	-	-
C15 - C28	37	µg/L				-	-	-	<100	<100	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-
C29-C36	38	µg/L				-	-	-	<50	<50	-	-	-	-	-	-	-	-	<50	<50	-	-	-	-
+C10 - C36 (Sum of total)	39	µg/L				-	-	-	<50	<50	-	-	-	-	-	-	-	-	<50	<50	-	-	-	-
>C10 - C16 Fraction	40	µg/L	100			-	-	-	<100	<100	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-
>C16 - C34 Fraction	41	µg/L	100			-	-	-	<100	<100	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-
>C34 - C40 Fraction	42	µg/L	100			-	-	-	<100	<100	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-
C10 - C40 (Sum of total)	43	µg/L				-	-	-	<100	<100	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-
Naphthalene	44	µg/L				-	-	-	<5	<5	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-
Total BTEX	45	mg/L	0.001			-	-	-	<0.001	<0.001	-	-	-	-	-	-	-	-	<0.001	<0.001	-	-	-	-
F2-Napth (C10-C16)	46	mg/L	0.1			-	-	-	<0.1	<0.1	-	-	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-
F1 minus BTEX (C6-C10)	47	mg/L	0.02			-	-	-	<0.02	<0.02	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-
Benzene	48	µg/L			1	-	-	-	<1	<1	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-
Ethylbenzene	49	µg/L		3	300	-	-	-	<2	<2	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-
Toluene	50	µg/L		25	800	-	-	-	<2	<2	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-
Xylene (m & p)	51	µg/L				-	-	-	<2	<2	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-
Xylene (o)	52	µg/L				-	-	-	<2	<2	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-
Xylene Total	53	µg/L		20	600	-	-	-	<2	<2	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-
pH (Field)	54	pH_Units	0.01			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Nitrite + Nitrate as N	55	mg/L	0.01			0.09	<0.01	<0.01	<0.01		0.2	0.43	<0.01	<0.01	0.04	1.54	1.61	1.74	1.82		0.01	<0.01	0.02	<0.01
Nitrate + Nitrite (as N)	56	mg/L	0.01			-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	2.34	-	-	-	-
Ferrous Iron	57	mg/L	0.05			-	1.2	-	-	-	-	-	-	2.15	-	-	-	-	-	-	3.81	-	-	-
Ferrous Iron (Filtered)	58	mg/L				-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Aluminium	59	mg/L	0.01			0.29	-	0.05	0.046	0.02	-	-	-	-	-	0.012	0.04	0.04	0.03	0.029	-	-	0.02	-
Aluminium (Filtered)	60	mg/L	0.01			<0.01	<0.01	<0.01	<0.005	<0.005	0.01	0.25	<0.01	<0.01	<0.01	<0.005	0.02	<0.01	0.019	0.027	<0.01	<0.01	<0.01	<0.01
Antimony	61	mg/L			0.003	<0.001	-	<0.001	<0.0002	<0.0002	-	-	-	-	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	-	<0.001	-
Antimony (Filtered)	62	mg/L			0.003	<0.001	-	<0.001	<0.0002	<0.0002	-	-	-	-	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	-	<0.001	-
Arsenic	63	mg/L	0.001		0.01	0.012	-	0.003	0.0097	0.0099	-	-	-	-	-	0.0007	<0.001	0.003	0.0013	0.0006	-	-	0.003	-
Arsenic (Filtered)	64	mg/L	0.001		0.01	0.003	0.008	0.016	0.0072	0.0096	0.001	<0.001	<0.001	0.018	0.006	0.0002	<0.001	<0.001	0.0012	0.0005	0.006	0.002	0.018	0.025
Barium	65	mg/L			2	0.035	-	0.019	0.0306	0.0315	-	-	-	-	-	0.0385	0.033	0.022	0.027	0.0304	-	-	0.019	-
Barium (Filtered)	66	mg/L			2	0.027	-	0.031	0.0283	0.0309	-	-	-	-	-	0.0302	0.031	0.029	0.0247	0.032	-	-	0.050	-
Beryllium	67	mg/L			0.06	<0.001	-	<0.001	0.0001	<0.0001	-	-	-	-	-	0.0005	<0.001	<0.001	0.0011	0.0011	-	-	<0.001	-
Beryllium (Filtered)	68	mg/L			0.06	<0.001	-	<0.001	<0.0001	<0.0001	-	-	-	-	-	0.0003	<0.001	<0.001	0.001	0.0012	-	-	<0.001	-
Boron	69	mg/L			4	0.66	-	3.54	0.533	0.697	-	-	-	-	-	0.166	0.2	3.59	0.166	0.191	-	-	3.50	-
Boron (Filtered)	70	mg/L			4	0.68	-	0.86	0.516	0.679	-	-	-	-	-	0.162	0.19	0.24	0.157	0.195	-	-	0.32	-
Cadmium	71	mg/L	0.0001		0.002	<0.0001	-	<0.0001	0.00006	<0.00005	-	-	-	-	-	0.00032	0.0002	<0.0001	0.00025	0.00036	-	-	<0.0001	-
Cadmium (Filtered)	72	mg/L	0.0001		0.002	<0.0001	<0.0001	<0.0001	<0.00005	<0.00005	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.00023	0.0002	0.0002	0.00024	0.00037	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (hexavalent)	73	mg/L			0.05	<0.01	-	<0.01	<0.001	0.002	-	-	-	-	-	-	<0.01	<0.01	<0.001	<0.001	-	-	<0.01	-
Chromium (hexavalent) (Filtered)	74	mg/L			0.05	<0.01	-	<0.01	<0.001	<0.001	-	-	-	-	-	<0.01	<0.01	<0.01	<0.001	<0.001	-	-	<0.01	-

*Green cells are still being sampled					LocCode	DS04A	DS04B	DS04B	DS04B	DS04B	LP001	LP002	NRB01	NRB02	NRB03	NRB03	NRB03	NRB03	NRB03	NRB03	NRB04	NRB05	NRB05	NRB06
					Sampled_Date-Time	29/11/2017	18/07/2015	08/02/2018	16/05/2018	13/06/2018	22/04/2015	22/04/2015	14/06/2015	18/07/2015	13/06/2015	7/11/2017	29/11/2017	07/02/2018	15/05/2018	12/06/2018	18/07/2015	14/06/2015	07/02/2018	14/06/2015
				ADWG 2015 Aesthetic	ADWG 2015 Health																			
ChemName		**Units**	**EQL**			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-
Chromium (III+VI)	75	mg/L	0.001			0.001	-	<0.001	0.0004	0.0048	-	-	-	-	-	0.0002	<0.001	<0.001	0.0008	0.0011	-	-	<0.001	-
Chromium (III+VI) (Filtered)	76	mg/L	0.001			<0.001	<0.001	<0.001	0.0003	0.0002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.001	<0.001	0.0007	0.0009	<0.001	<0.001	<0.001	<0.001
Cobalt	77	mg/L				0.012	-	0.010	0.0118	0.0104	-	-	-	-	-	0.007	0.002	0.008	0.02	0.018	-	-	0.008	-
Cobalt (Filtered)	78	mg/L	0.001			0.005	-	0.023	0.0098	0.0106	0.002	0.047	-	-	-	0.0009	0.002	0.002	0.0157	0.016	-	-	0.008	-
Copper	79	mg/L	0.001	1	2	0.004	-	0.002	0.0006	0.0007	-	-	-	-	-	0.0108	0.01	0.002	0.0233	0.0288	-	-	0.002	-
Copper (Filtered)	80	mg/L	0.001	1	2	<0.001	0.002	<0.001	<0.0005	<0.0005	0.001	0.012	<0.001	<0.001	<0.001	0.009	0.008	0.008	0.0184	0.0297	<0.001	0.002	<0.001	0.002
Iron	81	mg/L	0.05	0.3		2.07	1.17	8.76	1.66	2	-	-	1.17	1.81	<0.05	0.381	0.64	9.18	0.147	0.109	4.8	13.6	8.39	9.31
Iron (Filtered)	82	mg/L	0.05	0.3		<0.05	0.35	1.72	1.26	1.79	<0.05	<0.05	0.8	<0.05	<0.05	0.005	0.38	<0.05	0.076	0.036	2.56	<0.05	1.94	6.4
Lead	83	mg/L	0.001		0.01	<0.001	-	<0.001	0.0002	<0.0001	-	-	-	-	-	0.0001	<0.001	<0.001	0.0003	0.0002	-	-	<0.001	-
Lead (Filtered)	84	mg/L	0.001		0.01	<0.001	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0002	<0.001	<0.001	<0.0001	0.0001	<0.001	<0.001	<0.001	<0.001
Manganese	85	mg/L		0.1	0.5	0.424	-	0.749	0.804	0.82	-	-	-	-	-	0.0293	0.018	0.782	0.133	0.0887	-	-	0.762	-
Manganese (Filtered)	86	mg/L	0.001	0.1	0.5	0.246	0.688	1.16	0.724	0.803	0.006	0.111	1.01	5.96	0.539	0.0018	0.017	0.002	0.115	0.0766	1.73	<0.001	3.48	1.14
Mercury	87	mg/L	0.0001		0.001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	-	-	-	-	-	<0.0001	<0.0001	0.0002	0.0001	-	-	<0.0001	-
Mercury (Filtered)	88	mg/L	0.0001		0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	89	mg/L			0.05	0.006	-	<0.001	0.0069	0.008	-	-	-	-	-	0.0006	<0.001	<0.001	0.0002	<0.0001	-	-	<0.001	-
Molybdenum (Filtered)	90	mg/L			0.05	0.005	-	0.006	0.0064	0.0071	-	-	-	-	-	0.0005	<0.001	<0.001	0.0001	<0.0001	-	-	0.003	-
Nickel	91	mg/L	0.001		0.02	0.014	-	0.036	0.0101	0.0133	-	-	-	-	-	0.112	0.086	0.047	0.103	0.109	-	-	0.056	-
Nickel (Filtered)	92	mg/L	0.001		0.02	0.012	0.026	0.014	0.0084	0.0106	0.005	0.168	0.004	0.001	0.097	0.0852	0.086	0.086	0.0888	0.113	0.008	0.002	0.032	0.002
Selenium	93	mg/L	0.01		0.01	<0.01	-	<0.01	0.0003	<0.0002	-	-	-	-	-	0.002	<0.01	<0.01	0.002	0.0024	-	-	<0.01	-
Selenium (Filtered)	94	mg/L	0.01		0.01	<0.01	<0.01	<0.01	0.0002	<0.0002	-	-	<0.01	<0.01	<0.01	0.002	<0.01	<0.01	0.0017	0.0031	<0.01	<0.01	<0.01	<0.01
Silver	96	mg/L	0.00001			-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-

*Green cells are still being sampled					LocCode	NRB06	NRB06	NRB06	NRB06	NRB06	NRB06	NRB07	NRB07	NRB08	NRB08	NRB08	NRB08	NRB08	NRB08	NRB09	NRB09	NRB09	NRB09
					Sampled_Date-Time	18/07/2015	6/11/2017	29/11/2017	07/02/2018	16/05/2018	17/06/2018	13/06/2015	07/02/2018	18/07/2015	6/11/2017	28/11/2017	07/02/2018	16/05/2018	17/06/2018	18/07/2015	6/11/2017	29/11/2017	08/02/2018
				ADWG 2015 Aesthetic	ADWG 2015 Health																		
ChemName		**Units**	**EQL**			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-
Anions Total	1	meq/L	0.01			-	20.2	19.7	20.4	19.2	20.5	-	40.3	-	49.5	47.3	42.1	48	51.8	-	277	254	262
Cations Total	2	meq/L	0.01			-	20.2	19.3	19.2	21.1	20.7	-	46.8	-	50	48.2	49.9	54.5	52.7	-	245	264	256
Ionic Balance	3	%	0.01			-	0.05	1.09	3.10	4.65	0.55	-	7.46	-	0.53	0.92	8.48	6.34	0.84	-	6.08	1.94	1.10
Electrical conductivity *(lab)	4	µS/cm	1			1110	1640	1700	1620	-		5560	3620	3650	3560	3540	3770	-		11,800	15,000	14,800	16400
pH (Lab)	5	pH_Units	0.01			7.36	8.14	7.97	7.51	7.66	7.31	7.13	6.72	7	6.63	6.25	6.18	5.61	5.59	7.41	7.56	7.58	7.11
TDS	6	mg/L	10	600		646	1190	1100	1020	902	962	4660	3000	3590	3680	3340	3570	3240	3440	11,300	17,800	18,000	17500
TSS	7	mg/L	1			6	-	-	-	-		-	-	18	-	-	-	-		22	-	-	-
Hardness as CaCO3	8	mg/L	1	200		355	616	593	603	656	656	2500	1680	2020	1890	1770	1860	2020	1960	4820	8370	8800	8520
Acidity (as CaCO3)	9	mg/L	1			19	79	45	49	-		17	38	78	52	26	37	-		64	144	80	75
Alkalinity (Hydroxide) as CaCO3	10	mg/L	1			<1	<1	<1	<1	<1	<1000	<1	<1	<1	<1	<1	<1	<1	<1000	<1	<1	<1	<1
Alkalinity (total) as CaCO3	11	mg/L	1			188	774	761	789	725	773	254	186	137	23	10	30	6	5	350	387	380	380
Bicarbonate	12	mg/L	1			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-
Alkalinity (Bicarbonate as CaCO3)	13	mg/L	1			188	774	761	789	725	773	254	186	137	23	10	30	6	5	350	387	380	380
Alkalinity (Bicarbonate)	14	mg/L				-	-	-	-	884.5	943.1	-	-	-	-	-	-	7.32	6.1	-	-	-	-
Alkalinity (Carbonate as CaCO3)	15	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate	16	mg/L	1			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-
Chloride	17	mg/L	1	250		112	165	156	163	168	177	672	383	295	285	254	276	267	299	1650	2690	2520	2440
Fluoride	18	mg/L	0.1			-	-	-	-	0.3	0.3	-	-	-	-	-	-	1.8	1.8	-	-	-	-
Silicon as SiO2 (Filtered)	19	mg/L	0.1			28.8	-	-	-	-		43.7	-	24.9	-	-	-	-		18.9	-	-	-
Sulphate (Filtered)	20	mg/L	1	250		236	-	5	-	1	2	2300	-	2020	-	1920	-	1940	2080	5860	-	8440	-
Sulphate	21	mg/L				-	3	-	2	-		-	1240	-	1970	-	1620	-		-	9280	-	8910
Calcium (Filtered)	22	mg/L	1			68	34	33	32	35	37	35	36	199	142	124	132	139	135	132	352	376	363
Magnesium (Filtered)	23	mg/L	1			45	129	124	127	138	137	585	386	371	372	354	373	407	393	1090	1820	1910	1850
Potassium (Filtered)	24	mg/L	1			10	16	15	15	21	21	10	7	15	13	11	11	16	16	33	64	60	58
Sodium (Filtered)	25	mg/L	1	180		100	171	162	155	172	162	493	301	241	276	290	284	315	304	1470	1750	2000	1940
Ammonia as N	26	mg/L	0.01			<0.01	0.7	0.66	0.80	1.39	1220	0.06	0.07	<0.01	0.04	0.02	0.03	0.03	40	0.07	0.4	0.22	0.39
Kjeldahl Nitrogen Total	27	mg/L	0.1			0.4	-	-	-	-		0.2	-	0.4	-	-	-	-		0.3	-	-	-
Nitrate (as N)	28	mg/L	0.01			<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.24	1.07	0.01	1.51	1.34	<0.01	<0.01	0.04	0.02
Nitrite (as N)	29	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total)	30	mg/L	0.1			0.4	-	-	-	-		0.2	-	0.4	-	-	-	-		0.3	-	-	-
Phosphorus	31	mg/L	0.01			0.04	-	-	-	-		<0.01	-	0.01	-	-	-	-		0.04	-	-	-
Reactive Phosphorus as P	32	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	33	mg/L				-	<5	<5	<5	-		-	<5	-	-	-	-	-		-	<5	<5	<5
C6 - C9	34	µg/L				-	-	-	-	<20	<20	-	-	-	<20	<20	<20	<20	<20	-	-	-	-
C6-C10	35	mg/L	0.02			-	-	-	-	<0.02	<0.02	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-
C10 - C14	36	µg/L				-	-	-	-	<50	<50	-	-	-	<50	<50	<50	<50	<50	-	-	-	-
C15 - C28	37	µg/L				-	-	-	-	<100	180	-	-	-	<100	<100	<100	<100	<100	-	-	-	-
C29-C36	38	µg/L				-	-	-	-	<50	<50	-	-	-	<50	<50	<50	<50	<50	-	-	-	-
+C10 - C36 (Sum of total)	39	µg/L				-	-	-	-	<50	180	-	-	-	-	<50	<50	<50	<50	-	-	-	-
>C10 - C16 Fraction	40	µg/L	100			-	-	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-
>C16 - C34 Fraction	41	µg/L	100			-	-	-	-	<100	170	-	-	-	-	-	-	<100	<100	-	-	-	-
>C34 - C40 Fraction	42	µg/L	100			-	-	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-
C10 - C40 (Sum of total)	43	µg/L				-	-	-	-	<100	170	-	-	-	-	<100	-	<100	<100	-	-	-	-
Naphthalene	44	µg/L				-	-	-	-	<5	<5	-	-	-	<5	<5	<5	<5	<5	-	-	-	-
Total BTEX	45	mg/L	0.001			-	-	-	-	<0.001	<0.001	-	-	-	-	-	-	<0.001	<0.001	-	-	-	-
F2-Napth (C10-C16)	46	mg/L	0.1			-	-	-	-	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-
F1 minus BTEX (C6-C10)	47	mg/L	0.02			-	-	-	-	<0.02	<0.02	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-
Benzene	48	µg/L			1	-	-	-	-	<1	<1	-	-	-	<1	<1	<1	<1	<1	-	-	-	-
Ethylbenzene	49	µg/L		3	300	-	-	-	-	<2	<2	-	-	-	<2	<2	<2	<2	<2	-	-	-	-
Toluene	50	µg/L		25	800	-	-	-	-	<2	<2	-	-	-	<2	<2	<2	<2	<2	-	-	-	-
Xylene (m & p)	51	µg/L				-	-	-	-	<2	<2	-	-	-	<2	<2	<2	<2	<2	-	-	-	-
Xylene (o)	52	µg/L				-	-	-	-	<2	<2	-	-	-	<2	<2	<2	<2	<2	-	-	-	-
Xylene Total	53	µg/L		20	600	-	-	-	-	<2	<2	-	-	-	<2	<2	<2	<2	<2	-	-	-	-
pH (Field)	54	pH_Units	0.01			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-
Nitrite + Nitrate as N	55	mg/L	0.01			<0.01	<0.01	0.02	<0.01	<0.01		<0.01	0.01	<0.01	0.24	1.09	0.03	1.51		<0.01	<0.01	0.04	0.02
Nitrate + Nitrite (as N)	56	mg/L	0.01			-	-	-	-	-	<0.01	-	-	-	-	-	-	-	1.34	-	-	-	-
Ferrous Iron	57	mg/L	0.05			3.36	-	-	-	-	-	-	-	26.5	-	0.22	1.66	<0.05	<0.05	10.2	-	-	-
Ferrous Iron (Filtered)	58	mg/L				-	-	-	-	-		-	-	-	0.17	-	-	-		-	-	-	-
Aluminium	59	mg/L	0.01			-	0.012	0.07	0.04	0.028	0.019	-	0.03	-	0.242	0.4	0.06	1.32	1.5	-	0.058	1.66	0.03
Aluminium (Filtered)	60	mg/L	0.01			<0.01	<0.005	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	<0.01	0.204	0.39	0.12	1.22	1.41	<0.01	<0.005	<0.01	<0.01
Antimony	61	mg/L			0.003	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	<0.001	-	0.0002	<0.001	<0.001	<0.0002	0.0006	-	0.0003	<0.001	<0.001
Antimony (Filtered)	62	mg/L			0.003	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	<0.001	-	<0.0002	<0.001	<0.001	<0.0002	<0.0002	-	<0.0002	<0.001	<0.001
Arsenic	63	mg/L	0.001		0.01	-	0.0184	0.014	0.003	0.0189	0.0245	-	0.003	-	0.0007	<0.001	0.004	0.0009	0.0011	-	0.0034	0.008	0.003
Arsenic (Filtered)	64	mg/L	0.001		0.01	0.02	0.0194	0.003	0.020	0.0168	0.0229	0.002	0.010	0.003	0.0005	<0.001	<0.001	0.0008	0.0008	0.001	0.0014	<0.001	0.001
Barium	65	mg/L			2	-	1.07	1.1	0.019	1.25	1.46	-	0.020	-	0.0202	0.019	0.019	0.0204	0.0213	-	0.0202	0.028	0.019
Barium (Filtered)	66	mg/L			2	-	1.04	0.921	1.23	1.12	1.43	-	0.025	-	0.0195	0.017	0.022	0.0184	0.0201	-	0.0185	0.02	0.023
Beryllium	67	mg/L			0.06	-	<0.0001	<0.001	<0.001	<0.0001	<0.0001	-	<0.001	-	0.0009	0.001	<0.001	0.0036	0.0041	-	<0.0001	<0.001	<0.001
Beryllium (Filtered)	68	mg/L			0.06	-	<0.0001	<0.001	<0.001	<0.0001	<0.0001	-	<0.001	-	0.0007	0.001	<0.001	0.0036	0.004	-	<0.0001	<0.001	<0.001
Boron	69	mg/L			4	-	0.254	0.27	3.46	0.251	0.288	-	3.50	-	0.264	0.29	3.51	0.272	0.338	-	3.78	3.12	3.41
Boron (Filtered)	70	mg/L			4	-	0.24	0.28	0.31	0.238	0.288	-	0.56	-	0.236	0.3	0.36	0.28	0.324	-	3.31	3.48	4.09
Cadmium	71	mg/L	0.0001		0.002	-	<0.00005	<0.0001	<0.0001	<0.00005	<0.00005	-	<0.0001	-	0.00097	0.0012	<0.0001	0.00138	0.00158	-	<0.00005	0.0071	<0.0001
Cadmium (Filtered)	72	mg/L	0.0001		0.002	<0.0001	<0.00005	<0.0001	<0.0001	<0.00005	<0.00005	0.0001	<0.0001	<0.0001	0.00095	0.0012	0.0006	0.00136	0.00163	<0.0001	<0.00005	0.0003	<0.0001
Chromium (hexavalent)	73	mg/L			0.05	-	-	<0.01	<0.01	<0.005	<0.015	-	<0.01	-	-	-	<0.01	0.019	0.019	-	-	<0.05	<0.01
Chromium (hexavalent) (Filtered)	74	mg/L			0.05	-	<0.01	<0.01	<0.01	<0.001	<0.001	-	<0.01	-	-	-	<0.01	0.018	0.024	-	<0.01	<0.01	<0.01

*Green cells are still being sampled					LocCode	NRB06	NRB06	NRB06	NRB06	NRB06	NRB06	NRB07	NRB07	NRB08	NRB08	NRB08	NRB08	NRB08	NRB08	NRB09	NRB09	NRB09	NRB09
					Sampled_Date-Time	18/07/2015	6/11/2017	29/11/2017	07/02/2018	16/05/2018	17/06/2018	13/06/2015	07/02/2018	18/07/2015	6/11/2017	28/11/2017	07/02/2018	16/05/2018	17/06/2018	18/07/2015	6/11/2017	29/11/2017	08/02/2018
				ADWG 2015 Aesthetic	ADWG 2015 Health																		
ChemName		**Units**	**EQL**			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-
Chromium (III+VI)	75	mg/L	0.001			-	0.0004	<0.001	<0.001	0.0002	0.0011	-	<0.001	-	0.0017	0.004	<0.001	0.0245	0.0437	-	0.0007	0.003	<0.001
Chromium (III+VI) (Filtered)	76	mg/L	0.001			<0.001	<0.0002	<0.001	<0.001	<0.0002	<0.0002	<0.001	<0.001	<0.001	0.0005	0.005	<0.001	0.0231	0.0386	<0.001	<0.0002	<0.001	<0.001
Cobalt	77	mg/L				-	0.0015	0.004	0.008	0.0021	0.001	-	0.008	-	0.37	0.442	0.010	0.651	0.625	-	0.0074	0.073	0.010
Cobalt (Filtered)	78	mg/L	0.001			-	0.0002	0.002	<0.001	0.0007	0.0007	-	0.049	-	0.357	0.449	0.401	0.62	0.619	-	0.0034	0.009	0.007
Copper	79	mg/L	0.001	1	2	-	<0.0005	0.001	0.002	<0.0005	<0.0005	-	0.002	-	0.0105	0.013	0.003	0.0289	0.0348	-	0.001	0.585	0.003
Copper (Filtered)	80	mg/L	0.001	1	2	<0.001	<0.0005	<0.001	<0.001	<0.0005	<0.0005	0.006	<0.001	0.002	0.0096	0.014	0.004	0.0251	0.0342	0.006	0.0014	0.001	<0.001
Iron	81	mg/L	0.05	0.3		3.97	8.8	6.1	8.12	12.4	12.8	2.8	8.37	25	0.173	0.06	9.42	0.039	0.204	9.75	12	11.1	8.76
Iron (Filtered)	82	mg/L	0.05	0.3		0.14	7.81	<0.05	8.01	9.46	10.1	<0.05	3.70	19.5	0.086	<0.05	1.44	0.012	0.045	0.58	8.06	<0.05	5.29
Lead	83	mg/L	0.001		0.01	-	<0.0001	<0.001	<0.001	0.0003	0.0001	-	<0.001	-	0.0002	<0.001	<0.001	0.0002	0.0003	-	0.0003	0.013	<0.001
Lead (Filtered)	84	mg/L	0.001		0.01	<0.001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	0.0002	0.0002	<0.001	<0.0001	<0.001	<0.001
Manganese	85	mg/L		0.1	0.5	-	0.846	0.731	0.747	0.537	0.6	-	0.744	-	1.5	1.07	0.747	0.682	0.804	-	0.625	1.13	0.742
Manganese (Filtered)	86	mg/L	0.001	0.1	0.5	2.12	0.809	0.67	0.924	0.469	0.57	0.093	0.616	7.7	1.46	1.04	1.80	0.622	0.809	12.9	0.586	0.753	0.952
Mercury	87	mg/L	0.0001		0.001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	-	-	<0.0001	<0.0001	<0.0001	0.0005	-	-	0.0002	<0.0001
Mercury (Filtered)	88	mg/L	0.0001		0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	89	mg/L			0.05	-	0.0019	0.001	<0.001	0.001	0.0017	-	<0.001	-	0.0002	<0.001	<0.001	<0.0001	0.0002	-	0.0009	<0.001	<0.001
Molybdenum (Filtered)	90	mg/L			0.05	-	0.0015	0.002	<0.001	0.001	0.0015	-	0.004	-	0.0001	<0.001	0.018	<0.0001	0.0001	-	0.0006	<0.001	0.001
Nickel	91	mg/L	0.001		0.02	-	0.0019	0.004	0.049	0.0017	0.0014	-	0.050	-	1.08	1.29	0.035	1.75	1.68	-	0.0265	0.25	0.040
Nickel (Filtered)	92	mg/L	0.001		0.02	<0.001	0.001	0.003	<0.001	0.0007	0.0012	0.044	0.054	0.007	1.09	1.32	1.08	1.52	1.69	0.004	0.0139	0.034	0.052
Selenium	93	mg/L	0.01		0.01	-	<0.0002	<0.01	<0.01	<0.0002	<0.0002	-	<0.01	-	0.0004	<0.01	<0.01	0.0007	0.0007	-	0.0005	<0.01	<0.01
Selenium (Filtered)	94	mg/L	0.01		0.01	<0.01	<0.0002	<0.01	<0.01	<0.0002	<0.0002	<0.01	<0.01	<0.01	0.0004	<0.01	<0.01	0.0006	0.0007	<0.01	0.0004	<0.01	<0.01
Silver	96	mg/L	0.00001			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-

Appendix C: Results of Pumping Test Program (KCB, 2015)

October 30, 2015

Novo Resources Corporation
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West Perth, 6005

Simon Pooley
Study Manager

Dear Mr. Pooley.

Beatons Creek Aquifer Testing

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1 INTRODUCTION

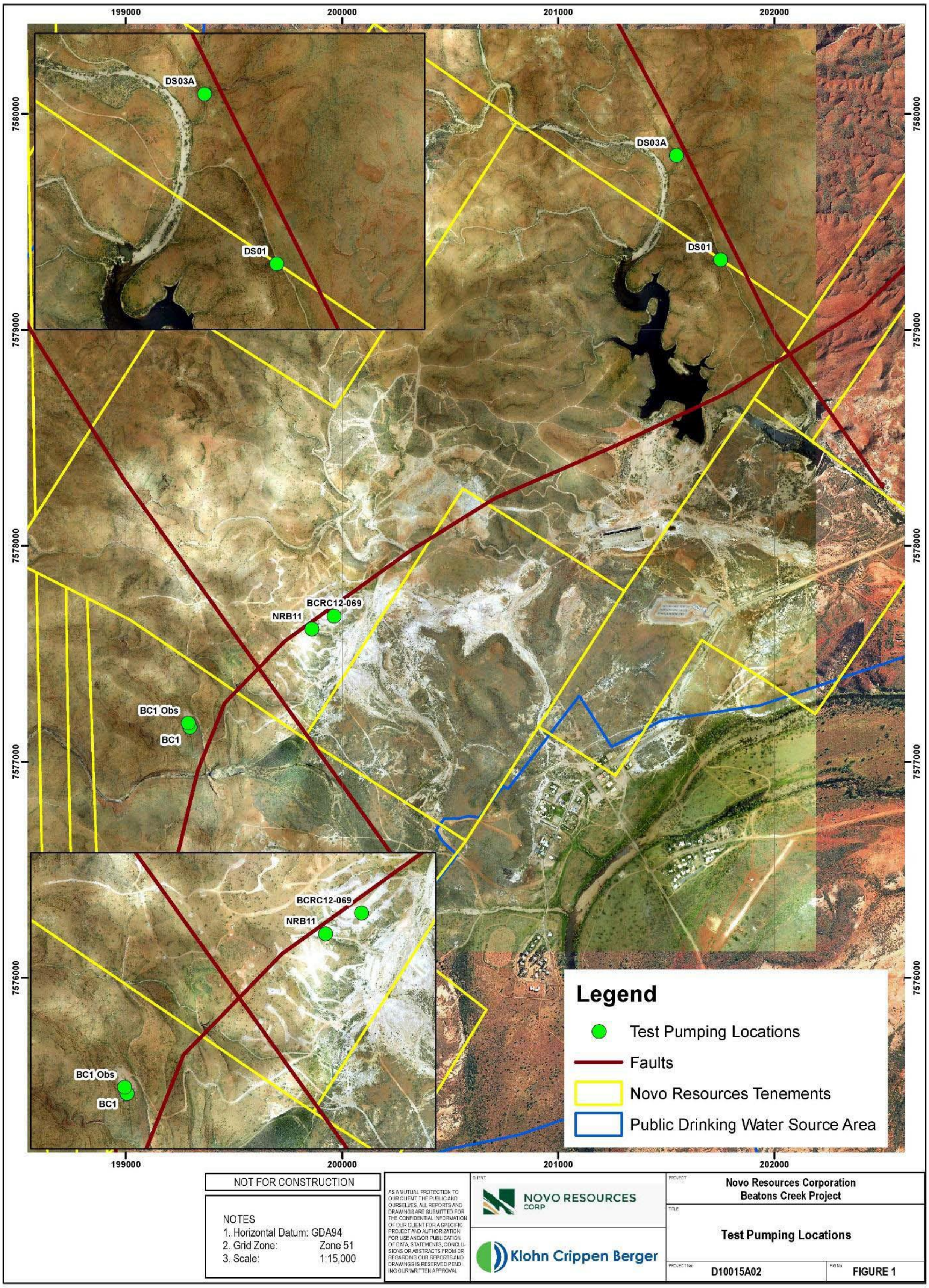
Klohn Crippen Berger Ltd (KCB) was commissioned by Novo Resources Corporation (NRC) to assess data from test pumping activities conducted at the Beatons Creek Project site. NRC are currently undertaking studies to support development of the Beatons Creek Project, located in the locality of Nullagine, Western Australia and are planning to commence mining at Beatons Creek in July of 2016.

An aquifer testing program was completed after the completion of the drilling program at Beatons Creek to allow for the estimation of aquifer hydraulic parameters, interpretation of hydrogeological characteristics and develop recommendations for sustainable yields.

These parameters/hydrogeological features include:

- Transmissivity: the transmissivity (T) of an aquifer is a measure of the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the saturated thickness of the aquifer. The unit of measurement is L^2/t ($Length^2/time$).
- Characterisation of hydraulic boundary conditions in the aquifer, which may comprise barrier or recharge boundaries (e.g. low permeability fault zones and zones of increased storage, respectively).
- Sustainable Yield: The sustainable yield in this context is defined as the yield that will not cause the water level in the bore to drop below a prescribed limit, identified from water strikes.

The results of the test pumping were used to develop hydraulic parameters for the Beatons Creek Project area and an initial sustainable pumping rate for DS01. The test pumping locations are presented in Figure 1.


199000
200000
201000
202000
7580000
7579000
7578000
7577000
7576000
DS03A
DS01
BCRC12-069
NRB11
BC1 Obs
BC1
Legend
Test Pumping Locations
Faults
Novo Resources Tenements
Public Drinking Water Source Area
NOT FOR CONSTRUCTION
NOTES
1. Horizontal Datum: GDA94
2. Grid Zone: Zone 51
3. Scale: 1:15,000
AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL
CLIENT
NOVO RESOURCES CORP
Klohn Crippen Berger
PROJECT
Novo Resources Corporation
Beatons Creek Project
TITLE
Test Pumping Locations
PROJECT No.
D10015A02
FIG No.
FIGURE 1

2 METHODOLOGY

2.1 Constant Rate Test

Constant rate tests (CRT) were performed on the production bores for a duration of between 1 and 6 days. During the CRTs, the groundwater level drawdowns were manually recorded in the both the pumped bores and observation bores located nearby. Abstraction rates were also monitored throughout the duration of the tests. In addition to estimating the aquifer hydraulic parameters, the CRTs were undertaken to identify:

- potential aquifer boundary conditions;
- the rate of groundwater drawdown propagation away from the production bores; and,
- preliminary estimates of the sustainable yield for production bores.

2.2 Recovery Monitoring

At the cessation of the CRTs, groundwater levels recovered (termed residual drawdown) within the production bores. Measurement of the recovering groundwater levels were conducted until groundwater levels were within 90% of pre-CRT levels where possible.

Prior to the commencement of the test pumping program, static groundwater levels were measured in the production bores to allow drawdown calculations during test pumping. Groundwater level measurements were collected from a fixed reference point (e.g. top of casing) using a dip meter and data-loggers equipped with pressure transducers.

2.3 Hydraulic Parameter Solution: Cooper-Jacob Straight-Line Method

Aquifer parameters were estimated from the test pumping results using the Cooper-Jacob Straight-Line method (Cooper and Jacob, 1946). This analytical solution for estimating hydraulic parameters assumes that flow to a bore is in a confined and leaky aquifer that is homogeneous, isotropic, of uniform thickness (including constant temperature and viscosity), and of infinite areal extent. The limitations associated with these assumptions are presented in Table 2-1.

Although this analytical solution for calculating aquifer parameters is based on assumptions not applicable to actual site conditions (e.g. the aquifer is not of infinite areal extent, nor is it a homogeneous system, etc), the resultant hydraulic parameters from these calculations are interpreted to be representative of the tested aquifer system within the vicinity of the production bore and the regional aquifer system.

Table 2-1 Assumptions for applying analytical methods to test pumping data

Assumption	Limitation
Aquifer is infinite	All aquifers have a limited extent due to no-flow or recharge boundaries, so the aquifer is big but not infinite
Aquifer is confined	Often fractures in the aquifer are connected through smaller fractures to the surface of phreatic aquifer on top, which implies semi-confined or unconfined conditions
Darcian flow in fracture network	In fractures and under high abstraction rates, non-linear or turbulent flow will occur.
Well penetrates aquifer fully	Usually the bores are penetrating the aquifer, consisting of a single fracture and matrix. In most cases, even overlying fractures are penetrated.

The following equation provides a summary of the Cooper-Jacob solution for the calculation of aquifer transmissivity:

$$T = \frac{2.3Q}{4\pi\Delta s}$$

Where:

- T - transmissivity (m^2/d);
- Q - abstraction rate (m^3/d);
- Δs - drawdown per log cycle (m).

The recorded water level drawdown data curves of drawdown versus time are plotted on a semi-log graph with time along the x-axis and drawdown on the y-axis. The data analysis is done by curve matching: the late time data is identified and forms a straight line on the plot. The gradient of the straight (Δs) line is then used to estimate a transmissivity value.

2.4 FC Method – Sustainable Yield

Results obtained from short duration test pumping programs using conventional analytical solutions do not take into consideration the heterogeneity of the aquifer being tested, and often do not adequately describe the drawdown response to pumping. This often results in an over estimation of the sustainable yield for production bores. Therefore, conventional models developed for homogeneous porous aquifers might not be viable in fractured rock systems.

The Flow Characteristic (FC) method (van Tonder et. al., 1998) has been specifically developed to develop sustainable yields of bores from pumping test data in fractured rock aquifers. The FC method considers boundary conditions, drawdown derivatives and rainfall recharge to groundwater to evaluate the probable sustainable yield of bores drilled in fractured rock aquifers. (Note that the sustainable yields reported in this document are conservative since recharge estimations of 0 mm/annum were used in the calculations).

Drawdown in production bores are extrapolated by a Taylor series expansion around the late measurement points of drawdown. The time at the end of pumping has to be large enough that the drawdown has passed the early time drawdown flow behavior due to well bore storage, fracture flow and double porosity effects. The effects of boundaries on drawdown are incorporated by the implementation of image well theory (van Tonder et. al., 1998). An image well is a hypothetical well that simulates recharge or discharge at various locations to duplicate the effects on the flow system caused by a physical boundary.

A key advantage of the FC method is that a reasonable estimate of sustainable yield can be developed without water level data from an observation bore.

The method is an applicable analytical tool for the Mosquito Creek Formation aquifer because of its heterogeneous nature, fractured rock aquifer characteristics and presence of physical hydraulic boundaries (fault structures , dykes etc.).. Therefore, the FC method developed by van Tonder et al. (1998) was used in order to develop preliminary estimates of sustainable yield for production bores on the project site.

3 RESULTS

3.1 BC01

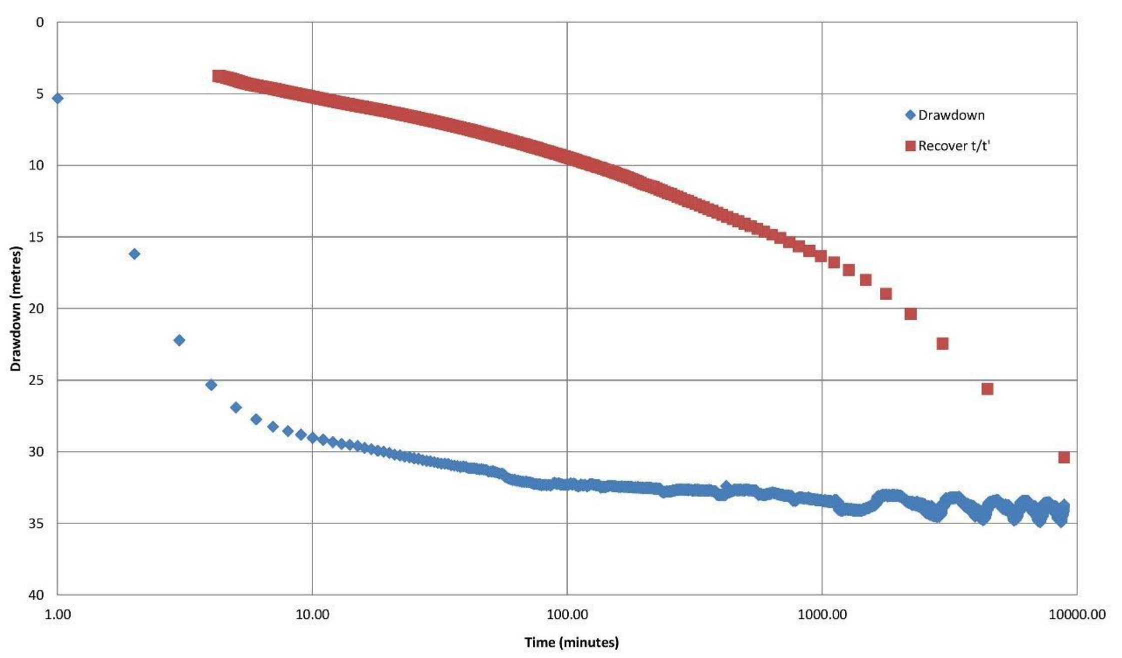
A CRT was undertaken on BC1 for a duration of 6 days at approximately 1.6L/s. Due to pump size limitations a higher pumping rate could not be attained. Hydraulic parameters calculated from the CRT test are presented in Table 3-1. Results of the CRT are discussed below in terms of the groundwater response to the pumping:

- Pumping bore BC1 – a total of 34.8 m drawdown was achieved over the CRT duration; and,
- Monitoring bore BC1OBS (located 16 meters northwest of BC1) – a total of 11.60 m of drawdown was recorded at the end of the test (Figure 2).

From the drawdown curve (Figure 2) the following have been identified:

- Slow but continuous drawdown for the initial ~16 hours, thereafter the water levels stabilised, indicating that the system reached steady-state conditions.
- 92% of the drawdown (to steady-state conditions) occurred during the initial 60 minutes of the test.

The late time data show diurnal fluctuations attributed to changes in temperature and/or atmospheric pressure.

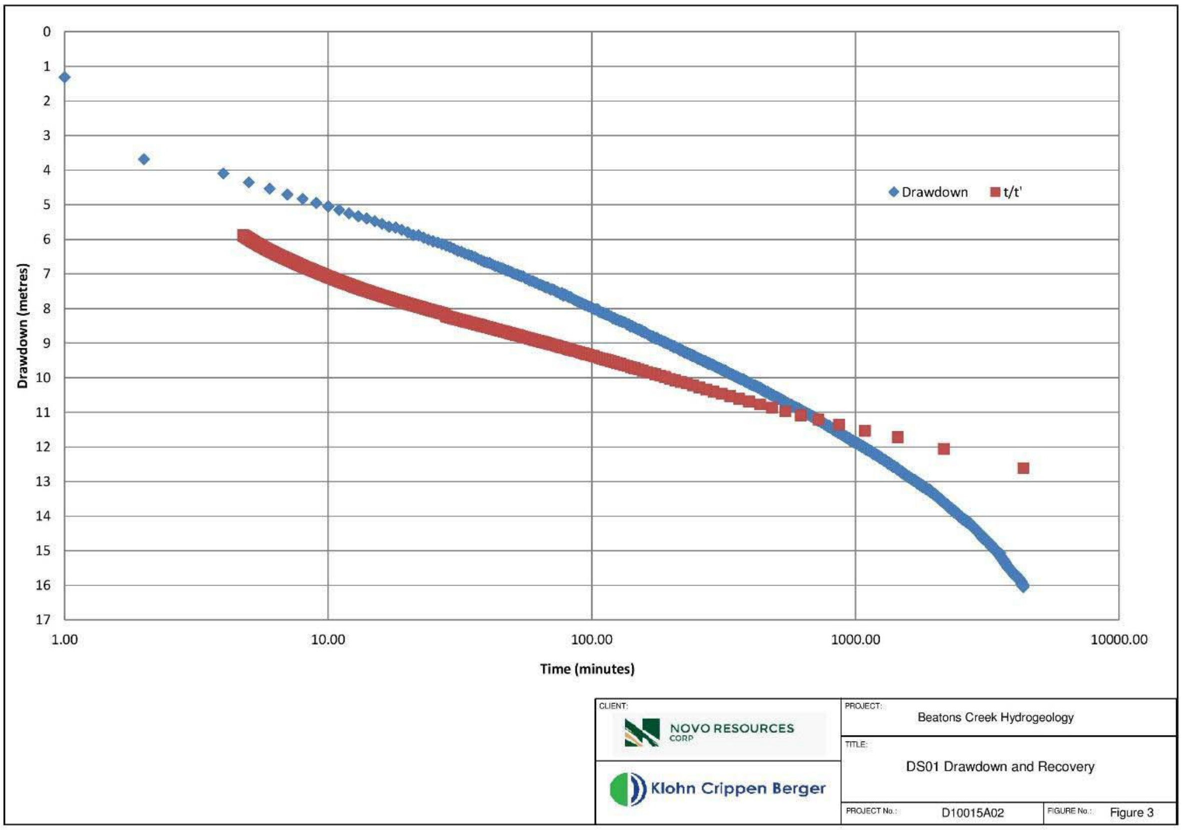


CLIENT: NOVO RESOURCES CORP	PROJECT: Beatons Creek Hydrogeology	
Klohn Crippen Berger	TITLE: BC01 Drawdown and Recovery	
	PROJECT No.: D10015A02	FIGURE No.: Figure 2

3.2 DS01

The CRT for DS01 was conducted at 5.2 L/s (449.28 m^3/day) for a duration of 72 hours. A total drawdown of 16.03 m was recorded over this period. From the drawdown curve presented in Figure 3, the following have been identified:

- Continuous drawdown of the groundwater level throughout the duration of the CRT indicates that the system did not reach steady state conditions.
- Approximately 14% of the available drawdown[1] was achieved over the duration of the CRT.
- The water levels decline at a uniform rate throughout most of the duration of the test. However, during the later stages of the test an increased rate of decline is observed.
- Water levels recovered to 70% of pre-test water levels within 12 hours.



3.2.1 Sustainable Yield

DS01 was drilled on the edge of a North-South trending dyke. All fracturing associated with dyke structures is limited to a narrow zone adjacent to the dyke. This results in a 'thin linear aquifer' with a higher permeability than the adjacent country rock. For the purposes of the estimation of the sustainable yield, the dyke and adjacent country rock are considered as 'no-flow' boundaries (2 no-flow boundaries) and most water is taken from the fractures on the fringe of the dyke. The

[1] Available drawdown is determined as the distance between the static water level and main water strike prior to commencement of the CRT.

poor recovery data supports the theory that adjacent rock has a low permeability and does not significantly contribute to the recharge of the thin linear aquifer adjacent to the dyke.

Using the FC Method, a sustainable yield of 3.8 L/s has been estimated. The following assumptions were used in the estimation of the sustainable yield:

- extrapolation time – 5 years,
- pumped for 24 hours per day,
- 0 mm annual effective recharge,
- available drawdown – 75 metres, and;
- 2 no-flow boundaries (dyke and adjacent country rock).

3.3 BCRC12-069

The depth of the pump inlet for the CRT on BCRC12-069 was set at 90 mbTOC. The CRT was conducted at 4.8 L/s (414.72 m^3/day). From the drawdown curve presented in Figure 4, the following have been identified:

- Water levels steadily declined for the first 700 minutes.
- Water levels declined sharply and the test had to be terminated after 870 minutes.
- The sharp decline in water levels at the end of the test suggest that the fracture intersected during drilling was dewatered.
- Water levels recovered to 50% of pre-test water levels within 20 hours.

The drawdown and recovery data for the CRT performed on KCB40 are presented in Figure 4.

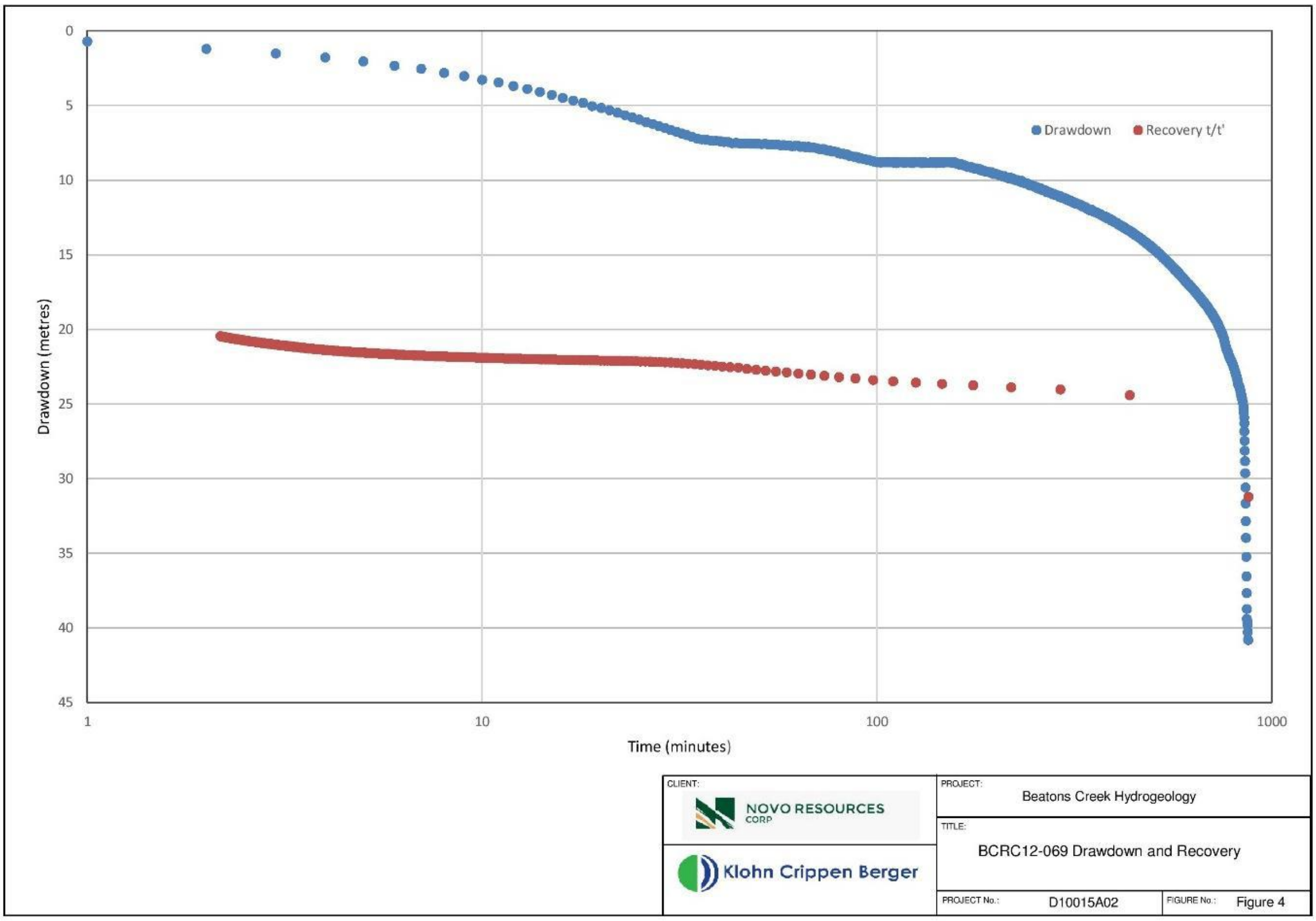

Drawdown
Recovery t/t'
Drawdown (metres)
Time (minutes)
0
5
10
15
20
25
30
35
40
45
1
10
100
1000
CLIENT:
NOVO RESOURCES CORP
Klohn Crippen Berger
PROJECT:
Beatons Creek Hydrogeology
TITLE:
BCRC12-069 Drawdown and Recovery
PROJECT No.:
D10015A02
FIGURE No.:
Figure 4

Table 3-1 Summary of test pumping activities

Pumping Test	Bore ID	Bore Type	Drilled Depth (m)	Screened Interval	Static Water Level (mbTOC)	Abstraction Rate (L/s)	Test Duration (hours)	Drawdown (m)	Hydraulic parameters					Comments
									T (m2/day) (Late time pumping)	T (m2/day) (Recovery)	K (m/day)	S (dimensionless) (pumping)	S (dimensionless) (recovery)	
1	DS01	Pumping	132	72 -132	8.08	5.2	72	16.03	8.4	19.3	3.22E-01	6.91E-03	3.96E-05	Pumping S should be ignored due to well losses.
	DS03A (DS01 Obs)	Observation	118	12 - 112	3.13	NA	72	11.5	8.4	21.9	2.19E-01	8.63E-03	2.69E-05	S values should not be calculated from recovery data.
2	BC1	Pumping	Unknown	Open Hole	6.02	1.6	148	34.89	6.3	25.3	NA	NA	3.34E-02	Pumping S should be ignored due to well losses.
	BC1 (Obs)	Observation	Unknown	Open Hole	5.97	NA	148	11.6	5.5	18.1	NA	5.80E-04	1.75E-02	S values should not be calculated from recovery data. Observation S during pumping is reasonable for low K aquifer.
3	BCRC12-069	Pumping	120	42 - 114	41.66	4.8	14.5	40.81	NA	NA	NA	NA	NA	Storage was depleted during the test. No hydraulic Parameters were able to be calculated.
	NRB11 (BCRC12-069)	Observation	132	24 - 90	10.84	NA	14.5	7.66	NA	NA	NA	NA	NA	

4 CLOSING

KCB are pleased to provide this letter-report to Novo Resources Corporation. Should you have any questions or concerns regarding this document please feel free to contact the undersigned on kvermaak@klohn.com or (08) 9486 5400.

This report is an instrument of service of Klohn Crippen Berger Ltd. The letter report has been prepared for the exclusive use of Novo Resources Corporation (Client) for the specific application to the Beatons Creek Project. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Kevin Vermaak

Hydrogeologist

KV:KV

REFERENCES

Bouwer H. and Rice R.C. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research, Vol. 12., No. 3.

Cooper H.H. and Jacob C.E. 1946. A generalized graphical method for evaluating formation constants and summarising well field history. Am. Gephys. Union. Trans. Vol. 27, pp 526

Appendix D: Beatons Creek Bore Construction Summary (Pendragon, 2015)

Bore Construction Details

Bore ID	Tenement	UTM (Zone 51K)		Elevation	Casing Elevation		Depth	Cased Depth	Screened Interval (mbgl)		Airlift yield	Static Water level
		Easting	Northing	(m AHD)	(m AHD)	(magl)	(m)	(m)	From	to	L/s	(mbgl)
NRB001	P46/1790	199,053	7,580,220	416.93	418	1.08	102	60	6	57	0.55	12.21
NRB002	E46/797	198,047	7,579,873	452.02	453.19	1.18	72	72	6	46	0.15	25.56
NRB003	E46/797	198,305	7,579,138	451.15	452.13	0.97	120	78	6	72	1.50	12.34
NRB004	M46/11	198,535	7,578,800	454.91	456.14	1.22	162	96	18	90	1.30	16.12
NRB005	M46/11	199,627	7,578,124	401.18	402.3	1.12	78	78	3	75	0.25	0.17
NRB006	P46/1806	200,233	7,580,127	408.87	410.17	1.3	60	24	6	18	0.10	9.89
NRB007	P46/1749	201,367	7,579,773	396.81	397.67	0.86	102	24	6	18	0.10	6.24
NRB008	M46/11	201,334	7,578,600	399.29	400.55	1.26	54	24	6	18	0.10	10.97
NRB009	M46/10	200,842	7,577,569	384.25	385.14	0.89	102	24	6	18	0.10	14.10
NRB010	E46/797	198,438	7,577,972	435.15	436.27	1.12	102	43	6	39	0.80	2.19
NRB011	M46/11	199,860	7,577,616	399.14	400.29	1.15	132	102	24	90	1.00	16.92
NRB012	P46/1749	199,487	7,577,538	415.46	-	-	150	3	-	-	0.10	13.24
NRB013	P46/1750	200,029	7,577,613	388.53	389.42	0.89	150	24	6	24	0.10	4.61
DS01	M46/11	201,751	7,579,325	397.24	398.46	1.22	132	132	72	132	8.50	7.03
DS02A	M46/11	202,011	7,578,884	387.86	388.47	0.61	60	24	6	18	0.20	5.79
DS02B	M46/11	201,988	7,578,875	387.83	388.92	1.09	124	120	12	117	8.00	4.62
DS02C	M46/11	-	-	-	-	-	144	0	-	-	0.20	n/a
DS03A	M46/11	201,546	7,579,808	393.09	394.13	1.03	118	118	12	118	5.00	2.89
DS03B	M46/11	201,553	7,579,804	392.95	394.12	1.16	174	72	16	66	0.40	2.01
DS04A	M46/11	-	-	-	-	-	100	3	-	-	0.10	8.21
DS04B	M46/11	201,297	7,580,259	399.02	400.12	1.07	162	44	2	44	0.20	4.43
DS04C	M46/11	-	-	-	-	-	50	3	-	-	0.05	n/a

SRK Report Client Distribution Record

Project Number: NOV005

Report Title: Beatons Creek H2 Hydrogeological Investigation

Date Issued: 10 August 2018

Name/Title	Company
Chris Goti, Environment and Approvals Manager	Novo Resources Ltd

Rev No.	Date	Revised By	Revision Details
0	02/08/2018	Brian Luinstra	Draft Report

APPENDIX J

NatureMap Database Search 2019

NatureMap Species Report

Created By Guest user on 14/10/2019

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	120° 05' 17" E,21° 52' 30" S
Buffer	20km
Group By	Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	661	2115
Priority 1	7	99
Priority 2	1	4
Priority 3	1	1
Priority 4	4	16
Protected under international agreement	2	2
Rare or likely to become extinct	5	99
TOTAL	**681**	**2336**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Rare or likely to become extinct					
1.	24093	*Dasyurus hallucatus (Northern Quoll)*		T	
2.	24473	*Falco hypoleucos (Grey Falcon)*		T	
3.	25238	*Liasis olivaceus subsp. barroni (Pilbara Olive Python)*		T	
4.	24180	*Macroderma gigas (Ghost Bat)*		T	
5.	24168	*Macrotis lagotis (Bilby, Dalgyte, Ninu)*		T	
Protected under international agreement					
6.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
7.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
Priority 1					
8.	13073	*Acacia aphanoclada*		P1	
9.	14087	*Acacia cyperophylla var. omearana*		P1	
10.	23522	*Acacia fecunda*		P1	
11.	2477	*Atriplex spinulosa*		P1	
12.	25058	*Ctenotus nigrilineatus (Pin-striped Fine-snout Skink, Black-lined Ctenotus)*		P1	
13.	2767	*Ptilotus wilsonii*		P1	
14.	48446	*Solanum sp. Mosquito Creek (A.A. Mitchell et al. AAM 10795)*		P1	
Priority 2					
15.	14329	*Indigofera ixocarpa*		P2	
Priority 3					
16.	20264	*Eucalyptus rowleyi*		P3	
Priority 4					
17.	30903	*Dasycercus blythi (Brush-tailed Mulgara, Ampurta)*		P4	
18.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
19.	2744	*Ptilotus mollis*		P4	
20.	43368	*Rhinonicteris aurantia (Orange Leaf-nosed bat)*		P4	
Non-conservation taxon					
21.	4895	*Abutilon lepidum*			
22.	42920	*Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)*			
23.	14113	*Abutilon sp. Pilbara (W.R. Barker 2025)*			
24.	3198	*Acacia acradenia*			
25.	11215	*Acacia adoxa var. adoxa*			
26.	44585	*Acacia adoxa var. adoxa x spondylophylla*			
27.	3209	*Acacia ampliceps*			
28.	3214	*Acacia ancistrocarpa (Fitzroy Wattle)*			
29.	44587	*Acacia aphanoclada x pyrifolia var. pyrifolia*			
30.	3224	*Acacia arrecta*			
31.	3241	*Acacia bivenosa*			
32.	13403	*Acacia colei*			

NatureMap
Mapping Western Australia's biodiversity

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area [1]
33.	17013	*Acacia colei var. colei*			
34.	13502	*Acacia coriacea subsp. pendens*			
35.	3272	*Acacia cowleana (Halls Creek Wattle)*			
36.	3326	*Acacia eriopoda (Broome Pindan Wattle)*			
37.	44582	*Acacia eriopoda x trachycarpa*			
38.	44590	*Acacia eriopoda x tumida var. pilbarensis*			
39.	3372	*Acacia holosericea (Candelbra Wattle, Liringgin)*			
40.	3377	*Acacia inaequilatera (Baderi)*			
41.	3434	*Acacia maitlandii (Maitland's Wattle)*			
42.	3447	*Acacia monticola (Gawar, Lilwardi)*			
43.	29996	*Acacia monticola x trachycarpa*			
44.	3471	*Acacia orthocarpa (Needleleaf Wattle)*			
45.	3500	*Acacia pruinocarpa (Gidgee)*			
46.	29016	*Acacia pyrifolia var. morrisonii*			
47.	29015	*Acacia pyrifolia var. pyrifolia*			
48.	13078	*Acacia sclerosperma subsp. sclerosperma*			
49.	8949	*Acacia sibirica (Bastard Mulga)*			
50.	20819	*Acacia sp. Ripon Hills (B.R. Maslin 8460)*			
51.	3553	*Acacia spondylophylla*			
52.	13070	*Acacia synchronicia*			
53.	3579	*Acacia trachycarpa (Minni Ritchi, Balgali)*			
54.	29992	*Acacia trachycarpa x tumida var. pilbarensis*			
55.	20319	*Acacia tumida var. pilbarensis*			
56.	3595	*Acacia victoriae (Bramble Wattle, Ngatunpa)*			
57.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
58.	25332	*Acanthophis wellsi (Pilbara Death Adder)*			
59.		*Acariformes sp.*			
60.	25536	*Accipiter fasciatus (Brown Goshawk)*			
61.		*Achnanthes exilis Kütz.*			
62.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
63.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
64.	2646	*Aerva javanica (Kapok Bush)*	Y		
65.		*Alona clathrata*			
66.	2648	*Alternanthera denticulata (Lesser Joyweed)*			
67.	2652	*Alternanthera nodiflora (Common Joyweed)*			
68.	17147	*Alysicarpus muelleri*			
69.	20018	*Amaranthus undulatus*			
70.	5277	*Ammannia baccifera*			
71.	5278	*Ammannia multiflora*			
72.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
73.	2383	*Amyema preissii (Wireleaf Mistletoe)*			
74.	11874	*Amyema sanguinea var. sanguinea*			
75.	25647	*Amytornis striatus (Striated Grasswren)*			
76.		*Aname mellosa*			
77.	24312	*Anas gracilis (Grey Teal)*			
78.	24316	*Anas superciliosa (Pacific Black Duck)*			
79.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
80.		*Anisops canaliculatus*			
81.		*Anisops hackeri*			
82.		*Anopheles annulipes s.l.*			
83.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
84.	25670	*Anthus australis (Australian Pipit)*			
85.		*Antichiropus sp.*			
86.		*Antiporus bakewelli*			
87.	24285	*Aquila audax (Wedge-tailed Eagle)*			
88.		*Arcella sp. P1*			
89.	41324	*Ardea modesta (great egret, white egret)*			
90.	24340	*Ardea novaehollandiae (White-faced Heron)*			
91.	24341	*Ardea pacifica (White-necked Heron)*			
92.	24610	*Ardeotis australis (Australian Bustard)*			
93.		*Areacandona 'iuno' (PSS)*			
94.	2961	*Argemone ochroleuca (Mexican Poppy)*	Y		
95.	17797	*Argemone ochroleuca subsp. ochroleuca*	Y		
96.		*Argiocnemis rubescens*			
97.	207	*Aristida contorta (Bunched Kerosene Grass)*			
98.	210	*Aristida holathera*			
99.		*Arrenurus (Arrenurus) ensifer*			
100.		*Arrenurus (Micruracarus) purpureus*			
101.		*Arrenurus sp. 9 (nr pseudaffinis) (PSW)*			
102.	25566	*Artamus cinereus (Black-faced Woodswallow)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
103.	24355	*Artamus minor (Little Woodswallow)*			
104.	24356	*Artamus personatus (Masked Woodswallow)*			
105.	25320	*Aspidites melanocephalus (Black-headed Python)*			
106.	4740	*Atalaya hemiglauca (Whitewood)*			
107.	2453	*Atriplex codonocarpa (Flat-topped Saltbush)*			
108.		*Australiobates queenslandensis*			
109.		*Australutica sp.1*			
110.		*Austroagrion pindrina/Ischnura heterosticta*			
111.		*Austropeplea lessoni*			
112.		*Axonopsella nr eremita (PSW)*			Y
113.	24318	*Aythya australis (Hardhead)*			
114.		*Barnardius zonarius*			
115.		*Batrachomatus wingi*			
116.		*Bdelloidea sp. 2:2*			
117.	5183	*Bergia ammannioides*			
118.	5186	*Bergia trimera*			
119.		*Berosus dallasae*			
120.		*Berosus nr josephenae (was Pilbara sp 3) (PSW)*			
121.	7854	*Bidens bipinnata (Bipinnate Beggartick)*	Y		
122.		*Bidessodes denticulatus*			
123.		*Bolboleaus trifoveicollis*			
124.	6606	*Bonamia media*			
125.	6608	*Bonamia pannosa*			
126.	24251	*Bos taurus (European Cattle)*	Y		
127.		*Brachionus angularis*			
128.		*Brachionus calyciflorus*			
129.		*Brachionus dichotomus*			
130.		*Brachionus falcatus*			
131.		*Brachionus leydigii*			
132.	750	*Bulbostylis barbata*			
133.	24359	*Burhinus grallarius (Bush Stone-curlew)*			
134.	25715	*Cacatua roseicapilla (Galah)*			
135.	25716	*Cacatua sanguinea (Little Corella)*			
136.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
137.	2864	*Calandrinia ptychosperma*			
138.	2872	*Calandrinia tepperiana*			
139.	14090	*Calocephalus beardii*			
140.		*Caloneis silicula (Ehr.) Cl.*			
141.	5446	*Calytrix carinata*			
142.	24254	*Camelus dromedarius (Dromedary, Camel)*	Y		
143.		*Carenum pulchrum*			
144.		*Carenum venustum*			
145.	25015	*Carlia munda (Shaded-litter Rainbow Skink)*			
146.	2949	*Cassytha capillaris*			
147.	42620	*Caulerpa chemnitzia*			
148.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
149.	29721	*Cenchrus setiger (Birdwood Grass)*	Y		
150.	7919	*Centipeda minima (Spreading Sneezewood, Kanjirralaa, Inteng-inteng, Karengkal, Kata-palkalpa, Munyu-parnti-parnti)*			
151.	1126	*Centrolepis eremica*			
152.		*Cephalodella gibba*			
153.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
154.		*Chaoborus punctilliger*			
155.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
156.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
157.		*Chydorus eurynotus*			
158.	42311	*Cinclosoma marginatum (Western Quail-thrush)*			
159.	24289	*Circus assimilis (Spotted Harrier)*			
160.	2988	*Cleome viscosa (Tickweed, Tjinduwadhu)*			
161.		*Cloeon sp. P1 (PSW)*			
162.		*Coelopynia pruinosa*			
163.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
164.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
165.	24363	*Coracina novaehollandiae subsp. subpallida (Black-faced Cuckoo-shrike)*			
166.	18409	*Corchorus lasiocarpus subsp. lasiocarpus*			
167.	4862	*Corchorus parviflorus*			
168.	4867	*Corchorus walcottii (Woolly Corchorus)*			
169.	24416	*Corvus bennetti (Little Crow)*			
170.	25593	*Corvus orru (Torresian Crow)*			
171.	16780	*Corymbia candida subsp. dipsodes*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
172.	17093	*Corymbia hamersleyana*			
173.	17092	*Corymbia opaca*			
174.	25701	*Coturnix ypsilophora (Brown Quail)*			
175.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
176.	25595	*Cracticus tibicen (Australian Magpie)*			
177.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
178.	3774	*Crotalaria cunninghamii (Green Birdflower, Bilbun)*			
179.	3783	*Crotalaria medicaginea*			
180.	20179	*Crotalaria medicaginea var. neglecta*			
181.	25458	*Ctenophorus caudicinctus (Ring-tailed Dragon)*			
182.	24865	*Ctenophorus caudicinctus subsp. caudicinctus (Ring-tailed Dragon)*			
183.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
184.	24882	*Ctenophorus nuchalis (Central Netted Dragon)*			
185.	25036	*Ctenotus duricola*			
186.	25043	*Ctenotus grandis subsp. titan*			
187.	25045	*Ctenotus helenae*			
188.	25463	*Ctenotus pantherinus (Leopard Ctenotus)*			
189.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
190.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
191.	41721	*Cucumis variabilis*			
192.		*Culex sp.*			
193.	17439	*Cullen lachnostachys*			
194.	17118	*Cullen leucanthum*			
195.	17447	*Cullen pustulatum*			
196.	15714	*Cullen stipulaceum*			
197.	25466	*Cyclodomorphus melanops (Slender Blue-tongue)*			
198.	25090	*Cyclodomorphus melanops subsp. melanops (Slender Blue-tongue)*			
199.	25376	*Cyclorana platycephala (Water-holding Frog)*			
200.	24322	*Cygnus atratus (Black Swan)*			
201.		*Cylotella stelligera Cl. & Grun.*			
202.	279	*Cymbopogon ambiguus (Scentgrass)*			
203.	789	*Cyperus difformis (Rice Sedge)*			
204.	798	*Cyperus iria*			
205.	814	*Cyperus squarrosus*			
206.	818	*Cyperus vaginatus (Stiffleaf Sedge)*			
207.		*Cypretta sp PSW074*			
208.	25547	*Dacelo leachii (Blue-winged Kookaburra)*			
209.	7424	*Dampiera candicans*			
210.	24091	*Dasykaluta rosamondae (Little Red Kaluta)*			
211.	24998	*Delma elegans*			
212.	25001	*Delma nasuta*			
213.	25002	*Delma pax*			
214.	24325	*Dendrocygna eytoni (Plumed Whistling Duck)*			
215.		*Dero nivea*			
216.		*Diacyclops humphreysi humphreysi*			
217.		*Diacyclops sobeprolatus*			
218.		*Diatoma vulgaris Bory*			
219.	7164	*Dicladanthera forrestii*			
220.		*Dicrotendipes P5 (=balciunasi?) (PSW)*			
221.		*Dicrotendipes jobetus*			
222.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
223.	24940	*Diplodactylus pulcher*			
224.	24944	*Diplodactylus savagei (Southern Pilbara Beak-faced Gecko)*			
225.		*Diplonychus eques*			
226.	24899	*Diporiphora valens (Southern Pilbara Tree Dragon)*			
227.	4759	*Dodonaea coriacea*			
228.	24470	*Dromaius novaehollandiae (Emu)*			
229.	2504	*Dysphania plantaginella*			
230.	11653	*Dysphania rhadinostachya subsp. inflata*			
231.	11890	*Dysphania rhadinostachya subsp. rhadinostachya*			
232.	328	*Echinochloa colona (Awnless Barnyard Grass)*	Y		
233.		*Ecnomus pilbarensis*			
234.		*Ecnomus sp. AV16 (PSW)*			
235.	41406	*Egernia cygnitos (Western Pilbara Spiny-tailed Skink)*			
236.	25094	*Egernia formosa*			
237.		*Egretta garzetta*			
238.		*Egretta novaehollandiae*			
239.	6682	*Ehretia saligna (False Cedar)*			
240.	14301	*Ehretia saligna var. saligna*			
241.		*Elanus axillaris*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
242.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
243.	24631	*Emblema pictum (Painted Finch)*			
244.		*Enithares sp.*			
245.	357	*Enneapogon caerulescens (Limestone Grass)*			
246.	365	*Enneapogon polyphyllus (Leafy Nineawn)*			
247.		*Eodiaptomus lumholtzi*			
248.		*Eolophus roseicapillus*			
249.		*Eosphora najas*			
250.	25578	*Ephippiorhynchus asiaticus (Black-necked Stork)*			
251.		*Epithemia smithii Carruthers*			
252.	24570	*Epthianura tricolor (Crimson Chat)*			
253.	24257	*Equus asinus (Donkey)*	Y		
254.	15124	*Eragrostis amabilis*	Y		
255.	375	*Eragrostis cumingii (Cuming's Love Grass)*			
256.	398	*Eragrostis tenellula (Delicate Lovegrass)*			
257.	24837	*Eremiornis carteri (Spinifex-bird)*			
258.	16940	*Eremophila lanceolata*			
259.	17169	*Eremophila latrobei subsp. glabra*			
260.	17576	*Eremophila latrobei subsp. latrobei*			
261.	7234	*Eremophila longifolia (Berrigan, Tulypurpa)*			
262.	400	*Eriachne aristidea*			
263.	3871	*Erythrina vespertilio (Yulbah)*			
264.	35343	*Eucalyptus camaldulensis subsp. refulgens*			
265.	5655	*Eucalyptus gamophylla (Twin-leaf Mallee, Warilu)*			
266.	18088	*Eucalyptus leucophloia subsp. leucophloia*			
267.		*Euchlanis dilatata*			
268.		*Eucyclops australiensis*			
269.	35303	*Euphorbia australis var. subtomentosa*			
270.	4620	*Euphorbia boophthona (Gascoyne Spurge)*			
271.	9048	*Euphorbia careyi*			
272.	12097	*Euphorbia tannensis subsp. eremophila (Desert Spurge)*			
273.	24368	*Eurostopodus argus (Spotted Nightjar)*			
274.		*Eurysticta coolawanyah*			
275.	11416	*Evolvulus alsinoides var. decumbens*			
276.	11200	*Evolvulus alsinoides var. villosicalyx*			
277.	25621	*Falco berigora (Brown Falcon)*			
278.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
279.	25623	*Falco longipennis (Australian Hobby)*			
280.	24041	*Felis catus (Cat)*	Y		
281.		*Filinia cf. pejleri (SAP)*			
282.	851	*Fimbristylis dichotoma (Eight Day Grass)*			
283.	12159	*Fimbristylis simulans*			
284.	35558	*Flaveria trinervia (Speedy Weed)*	Y		
285.		*Flosculariidae sp.*			
286.	12013	*Flueggea virosa subsp. melanthesoides (Dogwood, Guwal)*			
287.		*Fragilaria ulna (Nitz.) Lange Bertalot*			
288.	25727	*Fulica atra (Eurasian Coot)*			
289.	25301	*Furina ornata (Moon Snake)*			
290.	42314	*Gavicalis virescens (Singing Honeyeater)*			
291.	24956	*Gehyra pilbara*			
292.	24958	*Gehyra punctata*			
293.	24957	*Gehyra purpurascens*			
294.	24959	*Gehyra variegata*			
295.	24401	*Geopelia cuneata (Diamond Dove)*			
296.	25585	*Geopelia striata (Zebra Dove)*			
297.	24404	*Geophaps plumifera (Spinifex Pigeon)*			
298.	25530	*Gerygone fusca (Western Gerygone)*			
299.		*Glaphyromorphus sp.*			Y
300.		*Gomphonema affine Kütz.*			
301.	18363	*Gomphrena canescens subsp. canescens*			
302.	2680	*Gomphrena cunninghamii*			
303.	2683	*Gomphrena leptoclada*			
304.	18257	*Gomphrena leptoclada subsp. leptoclada*			
305.	12517	*Goodenia cusackiana*			
306.	7521	*Goodenia lamprosperma*			
307.	7526	*Goodenia microptera*			
308.	10982	*Goodenia stobbsiana*			
309.	4910	*Gossypium australe (Native Cotton)*			
310.	4918	*Gossypium robinsonii (Wild Cotton)*			
311.	24443	*Grallina cyanoleuca (Magpie-lark)*			

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312.		*Gretacarus sp.*			
313.	2079	*Grevillea pyramidalis (Caustic Bush, Tjungu)*			
314.	19570	*Grevillea pyramidalis subsp. leucadendron*			
315.	2121	*Grevillea wickhamii (Wickham's Grevillea)*			
316.	19478	*Grevillea wickhamii subsp. hispidula*			
317.		*Gyraulus hesperus*			
318.		*Gyrosigma fonticolum Hust. (in Foged)*			
319.	19137	*Hakea lorea subsp. lorea*			
320.	24295	*Haliastur sphenurus (Whistling Kite)*			
321.		*Haliplus pinderi*			
322.	6174	*Haloragis gossei*			
323.	23465	*Haloragis gossei var. gossei*			
324.	6180	*Haloragis trigonocarpa*			
325.	6705	*Heliotropium crispatum*			
326.	6712	*Heliotropium heteranthum*			
327.	17309	*Heliotropium pachyphyllum*			
328.	6718	*Heliotropium tenuifolium (Mamukata)*			
329.		*Hellyethira sp.*			
330.		*Hemicordulia tau*			
331.		*Hemicypris sp. BOS064*			
332.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
333.	24962	*Heteronotia spelea (Desert Cave Gecko, Pilbara Cave Gecko)*			
334.	4924	*Hibiscus burtonii*			
335.	4925	*Hibiscus coatesii*			
336.	4933	*Hibiscus leptocladus*			
337.	4942	*Hibiscus sturtii (Sturt's Hibiscus)*			
338.	11651	*Hibiscus sturtii var. campylochlamys*			
339.	47965	*Hieraaetus morphnoides (Little Eagle)*			
340.	25734	*Himantopus himantopus (Black-winged Stilt)*			
341.		*Hogna crispipes*			
342.		*Hydra sp.*			
343.		*Hydraena barbipes*			
344.		*Hydraena brittoni*			
345.		*Hydraena cf. rudallensis (PSW)*			
346.		*Hydrochus burdekinensis*			
347.		*Hydrochus eurypleuron*			
348.		*Hydrochus group 3 "black" (PSW)*			
349.		*Hydrochus obscuroaeneus*			
350.		*Hydrochus sp. P1 (PSW)*			
351.		*Hydrodroma sp.*			
352.		*Hydroglyphus grammopterus (=trilineatus)*			
353.		*Hydroglyphus leai*			
354.		*Hydroglyphus orthogrammus*			
355.		*Hydrovatus sp.*			
356.		*Hyphydrus lyratus*			
357.		*Ictinogomphus australis*			
358.		*Ilyodromus dikrus*			
359.		*Ilyodromus sp. PB*			
360.	3973	*Indigofera colutea (Sticky Indigo)*			
361.	3982	*Indigofera monophylla*			
362.	3985	*Indigofera rugosa*			
363.	3987	*Indigofera trita*			
364.		*Indolpium sp.*			
365.		*Ischnura aurora aurora*			
366.		*Isocypris williamsi (ex Ilyodromus sp. 413)*			
367.	3989	*Isotropis atropurpurea (Poison Sage)*			
368.	8088	*Ixiochlamys cuneifolia*			
369.		*Keratella procurva*			
370.		*Kiefferulus intertinctus*			
371.	24367	*Lalage tricolor (White-winged Triller)*			
372.		*Lamponina scutata*			
373.		*Lanatomyia sp.*			
374.		*Larsia albiceps*			
375.		*Lecane bulla*			
376.		*Lecane unguitata*			
377.		*Lepadella ovalis*			
378.		*Lepidiota squamulata*			
379.	3035	*Lepidium pedicellosum*			
380.	3038	*Lepidium pholidogynum*			
381.		*Leptocerus atsou*			

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382.		*Leptocerus sp. AV2 (atsou?) (PSW)*			
383.	30929	*Lerista jacksoni*			
384.	30925	*Lerista verhmens*			
385.		*Leydigia australis*			
386.	25005	*Lialis burtonis*			
387.	25661	*Lichmera indistincta (Brown Honeyeater)*			
388.	24582	*Lichmera indistincta subsp. indistincta (Brown Honeyeater)*			
389.		*Limnesia sp. 4 (PSW)*			
390.		*Limnochares australica*			
391.		*Limnogonus sp.*			
392.	37480	*Lobelia arnhemiaca*			
393.	4061	*Lotus cruentus (Redflower Lotus)*			
394.	30933	*Lucasium stenodactylum*			
395.	30934	*Lucasium wombeyi*			
396.		*Lychas sp. 2*			
397.		*Lycosa gibsoni*			
398.		*Macrochaetus altamirai*			
399.	25489	*Macropus robustus (Euro, Biggada)*			
400.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
401.	2538	*Maireana carnosa (Cottony Bluebush)*			
402.	2544	*Maireana georgei (Satiny Bluebush)*			
403.	2551	*Maireana melanocoma (Pussy Bluebush)*			
404.	2569	*Maireana triptera (Threewinged Bluebush)*			
405.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
406.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
407.	24549	*Malurus leucopterus subsp. leuconotus (White-winged Fairy-wren)*			
408.	24583	*Manorina flavigula (Yellow-throated Miner)*			
409.	16537	*Marsdenia angustata*			
410.	76	*Marsilea hirsuta (Nardoo)*			
411.		*Masasteron tealei*			
412.		*Masogloia smithii var. lacustris grun.*			Y
413.		*Mastogloia elliptica (Ag.) Cl.*			
414.		*Mastogloia elliptica var. danseii (thwaites) grun.*			
415.		*Mastogloia smithii Thwaites*			
416.		*Meedo houstoni*			
417.	5908	*Melaleuca eleuterostachya*			
418.	5915	*Melaleuca glomerata*			
419.	5923	*Melaleuca lasiandra*			
420.	47997	*Melanodryas cucullata (Hooded Robin)*			
421.	24736	*Melopsittacus undulatus (Budgerigar)*			
422.	25491	*Menetia surda*			
423.	25187	*Menetia surda subsp. surda*			
424.	24598	*Merops ornatus (Rainbow Bee-eater)*			
425.		*Mesocyclops darwini*			
426.		*Mesovelia hungerfordi*			
427.		*Microcarbo melanoleucos*			
428.		*Microcyclops varicans*			
429.		*Micronecta adelaidae (ex P4)*			
430.		*Micronecta micra*			
431.		*Microvelia (Austromicrovelia) peramoena*			
432.	25542	*Milvus migrans (Black Kite)*			
433.		*Minasteron minusculum*			
434.	25545	*Mirafra javanica (Horsfield's Bushlark, Singing Bushlark)*			
435.	25495	*Morethia ruficauda*			
436.	25193	*Morethia ruficauda subsp. exquisita*			
437.	24223	*Mus musculus (House Mouse)*	Y		
438.		*Navicula bryophila Petersen*			
439.		*Navicula cryptocephala Kütz.*			
440.		*Navicula cryptonella Lange-Bertalot*			
441.		*Navicula erifuga Lange-Bertalot*			
442.		*Navicula ilopangoensis Hust.*			
443.		*Navicula molestiformis Hust.*			
444.		*Navicula rhynchocephala Kütz.*			
445.		*Navicula subrhynchocephala Hust.*			
446.		*Navicula veneta Kütz.*			
447.		*Necterosoma regulare*			
448.		*Nematoda sp. 13 (PSS)*			
449.	25685	*Neochmia ruficauda (Star Finch)*			
450.	6791	*Newcastelia hexarrhena (Lambs' Tails)*			
451.	24095	*Ningaui timealeyi (Pilbara Ningaui)*			

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452.		*Nitzschia acicularis (Kütz.) W. Sm.*			
453.		*Nitzschia agnita Hust.*			
454.		*Nitzschia amphibia Grun.*			
455.		*Nitzschia compressa var. elongata (grun.) lange-bertalot*			
456.		*Nitzschia frustulum (Kütz.) Grun.*			
457.		*Nitzschia gracilis Hantz.*			
458.		*Nitzschia lanceolata W. Sm.*			Y
459.		*Nitzschia levidensis var. victoriae (grun.) cholnoky* *> cholnoky* *nitzschia levidensis v. victo*			
460.		*Nitzschia linearis (Ag.) W. Sm.*			
461.		*Nitzschia microcephala Grun.*			
462.		*Nitzschia palea (Kütz.) W. Sm.*			
463.		*Nitzschia perminuta (Grun.) M. Peragallo*			
464.		*Nitzschia reversa W. Sm.*			
465.		*Nitzschia sigma (Kütz.) W. Sm.*			
466.		*No invertebrates*			
467.	38421	*Notoleptopus decaisnei*			
468.	25499	*Notoscincus ornatus*			
469.	25197	*Notoscincus ornatus subsp. ornatus*			
470.	24742	*Nymphicus hollandicus (Cockatiel)*			
471.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
472.		*Oecetis sp. Pilbara 5 (PSW)*			
473.	7338	*Oldenlandia crouchiana*			
474.		*Onthophagus consentaneus*			
475.		*Onthophagus mjobergi*			
476.		*Onychohydrus sp.*			
477.	24618	*Oreoica gutturalis (Crested Bellbird)*			
478.		*Oribatida group 5 (PSS)*			
479.	48034	*Osphranter robustus (Euro, Biggada)*			
480.		*Oxus orientalis*			
481.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
482.		*Paracladopelma sp. P1 (nr M1) (PSW)*			
483.		*Paracyclops chiltoni*			
484.		*Paracymus pygmaeus*			
485.		*Paracymus spenceri*			
486.		*Paramerina sp. D (PSW)*			
487.		*Paranacaena horni*			
488.	515	*Paraneurachne muelleri (Northern Mulga Grass)*			
489.	24627	*Pardalotus rubricatus (Red-browed Pardalote)*			
490.	25682	*Pardalotus striatus (Striated Pardalote)*			
491.	518	*Paspalidium clementii (Clements Paspalidium)*			
492.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
493.		*Pellenes bitaeniata*			
494.	18462	*Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)*			
495.	34998	*Peripleura obovata*			
496.	3674	*Petalostylis cassioides*			
497.	48060	*Petrochelidon ariel (Fairy Martin)*			
498.	48061	*Petrochelidon nigricans (Tree Martin)*			
499.	24144	*Petrogale rothschildi (Rothschild's Rock-wallaby)*			
500.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
501.	24666	*Phalacrocorax melanoleucos subsp. melanoleucos (Little Pied Cormorant)*			
502.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
503.	24409	*Phaps chalcoptera (Common Bronzewing)*			
504.		*Phorticosomus gularis*			
505.	17626	*Phyllanthus erwinii*			
506.	14462	*Phyllanthus exilis*			
507.	4680	*Phyllanthus maderaspatensis*			
508.		*Pilbarascutigera incola*			
509.		*Pinnularia interurupta W. Sm.*			
510.		*Piona cumberlandensis*			
511.	24101	*Planigale ingrami (Long-tailed Planigale)*			
512.	24102	*Planigale maculata (Common Planigale)*			
513.	24842	*Platalea regia (Royal Spoonbill)*			
514.		*Plationus patulus*			
515.	42306	*Platyplectrum spenceri (Centralian Burrowing Frog)*			
516.		*Pleurosigma elongatum W. Sm.*			
517.	8167	*Pluchea dentex*			
518.	17816	*Pluchea ferdinandi-muelleri*			
519.	8168	*Pluchea rubelliflora*			

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	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
520.	8170	*Pluchea tetranthera*			
521.	8173	*Podolepis capillaris (Wiry Podolepis)*			
522.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
523.		*Polyarthra dolichoptera*			
524.	2898	*Polycarpaea corymbosa*			
525.	12075	*Polycarpaea corymbosa var. corymbosa*			
526.	2901	*Polycarpaea holtzei*			
527.	2903	*Polycarpaea longiflora*			
528.	41365	*Polygala glaucifolia*			
529.	6655	*Polymeria calycina*			
530.		*Polypedilum leei*			
531.		*Polypedilum nubifer*			
532.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
533.	25706	*Pomatostomus temporalis (Grey-crowned Babbler)*			
534.	24684	*Pomatostomus temporalis subsp. rubeculus (Grey-crowned Babbler)*			
535.	25199	*Proablepharus reginae*			
536.		*Procladius paludicola*			
537.		*Pseudagrion microcephalum*			
538.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
539.	25261	*Pseudechis australis (Mulga Snake)*			
540.		*Pseudocloeon hypodelum (ex Baetid genus3 WA sp. 2) (PSW)*			
541.	8189	*Pseudognaphalium luteoalbum (Jersey Cudweed)*			
542.	24234	*Pseudomys delicatulus (Delicate Mouse)*			
543.	24235	*Pseudomys desertor (Desert Mouse)*			
544.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
545.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
546.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
547.	25264	*Pseudonaja nuchalis (Gwardar, Northern Brown Snake)*			
548.	8192	*Pterocaulon sphacelatum (Apple Bush, Fruit Salad Plant)*			
549.	8193	*Pterocaulon sphaeranthoides*			
550.		*Ptilonorhynchus guttatus*			
551.	42323	*Ptilotula keartlandi (Grey-headed Honeyeater)*			
552.	2696	*Ptilotus astrolasius*			
553.	2698	*Ptilotus auriculifolius*			
554.	2706	*Ptilotus carinatus*			
555.	2711	*Ptilotus clementii (Tassel Top)*			
556.	2721	*Ptilotus exaltatus (Tall Mulla Mulla)*			
557.	2725	*Ptilotus fusiformis*			
558.	2734	*Ptilotus incanus*			
559.	2746	*Ptilotus nobilis (Tall Mulla Mulla)*			
560.	2747	*Ptilotus obovatus (Cotton Bush)*			
561.		*Ptygura sp.*			
562.		*Pyralidae Pilbara sp 2 (PSW)*			
563.		*Ranatra diminuta*			
564.		*Recifella sp.*			
565.		*Regimbartia attenuata*			
566.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
567.	13310	*Rhodanthe margarethae*			
568.		*Rhopalodia gibba (Ehr.) O. Mull.)*			
569.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
570.	4190	*Rhynchosia australis (Rhynchosia)*			
571.	4191	*Rhynchosia minima (Rhynchosia)*			
572.	30434	*Salsola australis*			
573.	2357	*Santalum lanceolatum (Northern Sandalwood, Yarnguli)*			
574.	13150	*Scaevola browniana subsp. browniana*			
575.	41660	*Schenkia australis*			
576.	599	*Schizachyrium fragile (Senale Redgrass)*			
577.		*Scirtidae sp.*			
578.	2600	*Sclerolaena burbidgeae*			
579.	2603	*Sclerolaena cornishiana (Cartwheel Burr)*			
580.	2604	*Sclerolaena costata*			
581.	2606	*Sclerolaena cuneata (Yellow Bindii)*			
582.	2607	*Sclerolaena densiflora*			
583.	2617	*Sclerolaena hostilis*			
584.	24200	*Scotorepens greyii (Little Broad-nosed Bat)*			
585.		*Sellephora pupula (Kütz) Mereschkowsky*			
586.	12279	*Senna artemisioides subsp. helmsii*			
587.	12280	*Senna artemisioides subsp. oligophylla*			
588.	12307	*Senna glutinosa subsp. glutinosa*			
589.	12309	*Senna glutinosa subsp. pruinosa*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
590.	12308	*Senna glutinosa subsp. x luerssenii*			
591.	12312	*Senna notabilis*			
592.	18450	*Senna symonii*			
593.	4196	*Sesbania cannabina (Sesbania Pea)*			
594.	4976	*Sida echinocarpa*			
595.	30948	*Smicrornis brevirostris (Weebill)*			
596.	7002	*Solanum diversiflorum*			
597.	7014	*Solanum horridum*			
598.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
599.	7029	*Solanum phlomoides*			
600.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
601.		*Spinasteron barlee*			
602.	629	*Sporobolus australasicus (Fairy Grass)*			
603.	7098	*Stemodia grossa (Marsh Stemodia, Mindjaara)*			
604.	7102	*Stemodia viscosa (Pagurda)*			
605.		*Sternopriscus pilbarensis*			
606.		*Stratiomyidae sp.*			
607.	8237	*Streptoglossa decurrens*			
608.	8240	*Streptoglossa odora*			
609.	24927	*Strophurus elderi*			
610.	7729	*Stylidium fluminense*			
611.	25307	*Suta punctata (Spotted Snake)*			
612.	4223	*Swainsona decurrens*			
613.	12356	*Swainsona formosa*			
614.	4231	*Swainsona kingii*			
615.	4244	*Swainsona stenodonta*			
616.	13339	*Synaptantha tillaeacea var. tillaeacea*			
617.		*Synchaeta oblonga*			
618.		*Tabanidae sp.*			
619.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
620.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
621.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
622.	30870	*Taeniopygia guttata (Zebra Finch)*			
623.	24175	*Taphozous georgianus (Common Sheath-tailed Bat)*			
624.		*Tasmanocoenis arcuata*			
625.		*Tasmanocoenis sp. E (PSW)*			
626.	49016	*Tephrosia densa*			
627.	19531	*Tephrosia rosea var. clementii*			
628.	17768	*Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)*			
629.	4287	*Tephrosia virens*			
630.		*Testudinella patina*			
631.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
632.	25202	*Tiliqua multifasciata (Central Blue-tongue)*			
633.		*Tiporus lachlani*			
634.		*Tiporus tambreyi*			
635.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
636.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
637.	6278	*Trachymene oleracea*			
638.	19043	*Trachymene oleracea subsp. oleracea*			
639.		*Triaenodes sp. P1=P2 (PSW)*			
640.	44240	*Trianthema cusackianum*			
641.		*Trianthema sp.*			
642.	44362	*Trianthema triquetrum*			
643.	4377	*Tribulus hirsutus*			
644.	4381	*Tribulus platypterus (Cork Hopbush)*			
645.	18072	*Tribulus suberosus*			
646.		*Trichocerca pusilla*			
647.		*Trichocerca similis*			
648.		*Trichocerca sp.*			
649.		*Trichocyclus gnalooma*			
650.	6727	*Trichodesma zeylanicum (Camel Bush, Kumbalin)*			
651.	11750	*Trichodesma zeylanicum var. zeylanicum*			
652.	48201	*Trigastrotheca molluginea*			
653.	679	*Triodia angusta*			
654.	681	*Triodia brizoides*			
655.	13131	*Triodia epactia*			
656.	696	*Triodia pungens (Soft Spinifex)*			
657.	704	*Triodia wiseana (Limestone Spinifex)*			
658.	48319	*Tripogonella loliiformis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
659.		*Tropocyclops confinis (ex Paracyclops sp. 6)*			
660.	24851	*Turnix velox (Little Button-quail)*			
661.	41428	*Uperoleia saxatilis (Pilbara Toadlet)*			
662.		*Urodacus hoplurus*			
663.	30716	*Vachellia farnesiana (Mimosa Bush)*	Y		
664.	25209	*Varanus acanthurus (Spiny-tailed Monitor)*			
665.	25210	*Varanus brevicauda (Short-tailed Pygmy Monitor)*			
666.	25211	*Varanus caudolineatus*			
667.	25212	*Varanus eremius (Pygmy Desert Monitor)*			
668.	25216	*Varanus giganteus (Perentie)*			
669.	25524	*Varanus panoptes (Yellow-spotted Monitor)*			
670.	25224	*Varanus pilbarensis (Pilbara Rock Monitor, Northern Pilbara Rock Goanna)*			
671.	25526	*Varanus tristis (Racehorse Monitor)*			
672.		*Venator yalkara*			
673.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			
674.		*Vestalenula marmonieri*			
675.	7390	*Wahlenbergia queenslandica*			
676.	7393	*Wahlenbergia tumidifructa*			
677.		*Wydundra kennedy*			
678.	731	*Xerochloa laniflora (Rice Grass)*			
679.	732	*Yakirra australiensis*			
680.		*Zyxomma elgneri*			
681.	24248	*Zyzomys argurus (Common Rock-rat)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

APPENDIX K

EPBC PMST Database Search 2019

Australian Government

Department of the Environment and Energy

EPBC Act Protected Matters Report

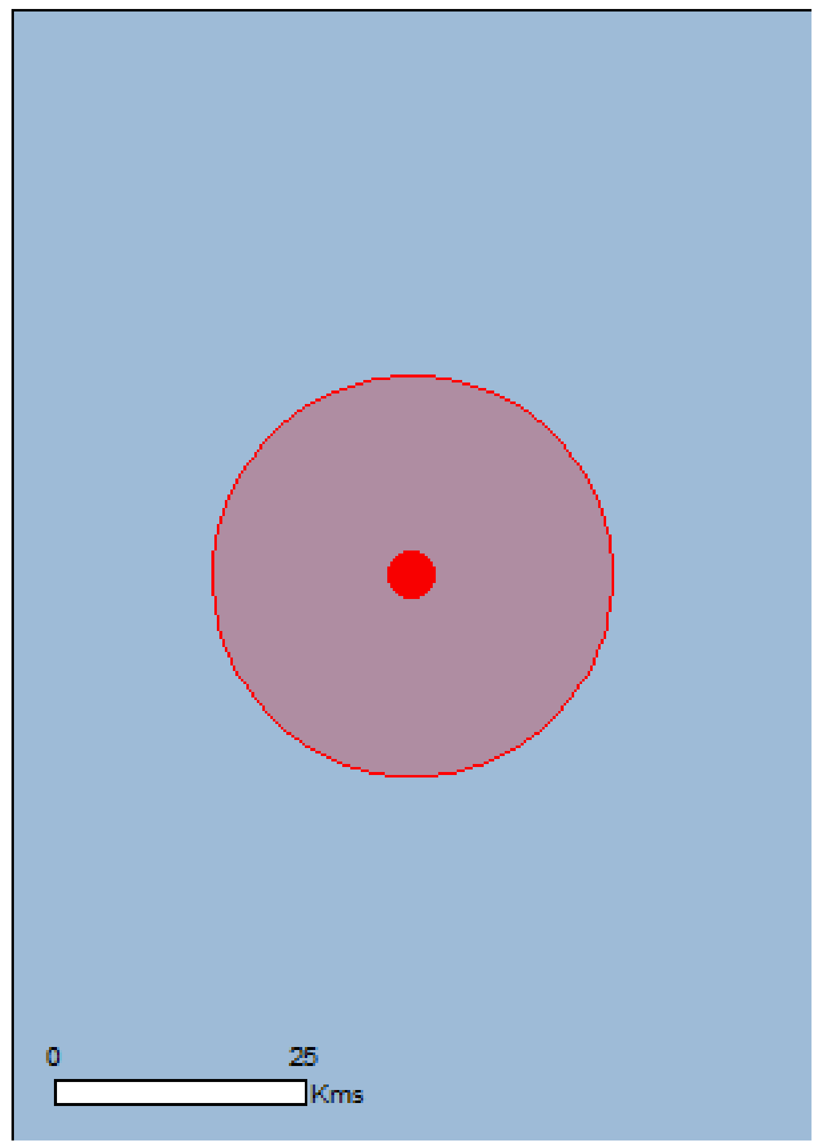
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

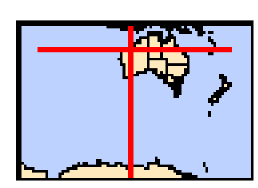
Report created: 14/10/19 14:29:17

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	9
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.87492 120.088

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX L

SRE Invertebrate Desktop Assessment

Bennelongia
Environmental Consultants

Beatons Creek Additional Tenement: Short-Range Endemic Invertebrate Desktop

Prepared for:

Novo Resources

March 2018
Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

Beatons Creek Additional Tenement: Short-Range Endemic Invertebrate Desktop

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Final	Stuart Halse		email	26 March 2018

K:\Projects\B_NRC_03\Report\Draft\BEC_BeatonsCk_SREdesktop_draft_12iii18.docx

EXECUTIVE SUMMARY

Novo Resources (Novo) is currently developing its Beatons Creek Palaeoplacer Gold Project and is looking to expand this into an additional adjacent tenement of 96.8 ha (the Project). The company is seeking environmental information on the Project area to inform future mine planning.

Beatons Creek is located immediately behind the small town of Nullagine in the eastern Pilbara region of Western Australia. At Beatons Creek Novo is exploring for gold-bearing conglomerates within the Hardey Sandstone Formation, part of the Fotesque Group, a thick sequence of ancient sedimentary and volcanic rocks. The Project area falls within the Nullagine catchments.

The Western Australian Environmental Protection Authority (EPA) requires that the Proponent considers the risk to short-range endemic invertebrates (SREs), which are species of ground-dwelling invertebrates with ranges of less than 10,000 km^2. SREs have patchy occurrences within this small range because they are confined to discontinuous, usually refugial, habitats. The EPA also considers risks to invertebrate species that are listed under conservation legislation or institutional arrangements.

This desktop review collated existing information on invertebrate species in groups with a high proportion of SRE species (the SRE Groups) as well as invertebrate species listed under conservation legislation in the vicinity of the Project. It also collected information about habitats likely to support SRE habitats within the Project. The invertebrate and habitat information were combined to assess the likelihood of any SRE or listed species being present in the Project area and whether these species were likely to be threatened by the Project

A search of records of the Western Australian Museum database showed that approximately 76 species from SRE Groups have been recorded in a 100 km by 100 km search area around the Project. The search area fauna appears to be dominated by arid-adapted species. A diverse assemblage of pseudoscorpions and scorpions, comprising 19 and 17 species respectively, was recorded. Mygalomorph spiders were moderately diverse (13 species), followed by scolopendrid centipedes (8) and slaters (7). Few species are known from the remaining groups - snails (3), polyxenid and *Antichiropus* millipedes (2 species each), soil centipedes (2), opilionids (1), scutigerids (1) and selenopid spiders (1). The Nullagine area appears to support fewer species than other regions of the Pilbara. Fourteen species in the area have linear ranges of less than 100 km and four were classed as potential SREs although only one of these, the pseudoscorpion *Xenolpium* `PSE063`, has reasonable likelihood of actually being an SRE.

The Project area comprises highly exposed hills and ridges that support only hummock grasslands and are not prospective for SREs. No listed invertebrates, confirmed or potential SREs were recorded within the Project area. The highly exposed, widespread and uniform nature of habitat at the Project, together with low number of potential SRE species in museum search results, suggest there is likely to be a depauperate community of terrestrial invertebrates present at the Project, none of which is likely to be an actual SRE species.

The Project area is of small extent (96.8 ha) and this small size, together with the lack of prospective SRE habitats in the Project area and low richness of species in SRE Groups in the vicinity, makes it unlikely the Project will affect the conservation status of any SRE or listed species in the local region. This conclusion is considered to be sufficiently robust that no field survey is required.

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1. INTRODUCTION

Novo Resources (Novo) is currently developing its Beatons Creek Palaeoplacer Gold Project and is looking to expand this into an additional adjacent tenement to the north. This additional tenement constitutes the Project in this report. The company is seeking environmental information on the Project to inform future mine planning.

Beatons Creek is located immediately behind the small town of Nullagine in the eastern Pilbara region of Western Australia (Figure 1). Novo is exploring for gold-bearing conglomerates within the Hardey Sandstone Formation, part of the Fotesque Group, a thick sequence of ancient sedimentary and volcanic rocks. The Project area falls within the Nullagine catchment. Beatons Creek, which has already received environmental approval, covers 389.5 ha and the Project comprises an additional 96.8 ha on the north side of Beatons Creek.

The Western Australian Environmental Protection Authority (EPA) requires that the Proponent considers the risk to short-range endemic invertebrates (SREs), which are species of ground-dwelling invertebrates with ranges of less than 10,000 km^2. SREs have patchy occurrences within this small range because they are confined to discontinuous, usually refugial, habitats (Harvey 2002). The EPA also considers risks to invertebrate species that are listed under conservation legislation or institutional arrangements (see section 3.1).

Information on likelihood of SRE and listed invertebrate species occurring in the Project area was compiled via desktop review. The review aimed to collate existing information on SREs and listed invertebrates in the vicinity of the Project, as well as to collect information about habitats likely to support SRE habitats within the Project.

This report addresses three objectives:

- Review known occurrences of SRE or listed invertebrate species in the vicinity of the Project;
- Describe and evaluate the prospectivity of habitats at the Project for SREs;
- Evaluate the likelihood of the Project having significant conservation impacts for SRE or listed invertebrate species.

2. FRAMEWORK

2.1. Conservation Framework

The small ranges of SRE invertebrates, combined with poor dispersal capacities, slow growth and low fecundity, make them particularly vulnerable to habitat loss or disturbance (Harvey 2002; Ponder and Colgan 2002). Consequently, SRE invertebrates form a category of species considered by the EPA in environmental impact assessments. The process used is outlined in *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2016a) and supporting technical guidance relating to SREs is provided by *Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016b). The latter provides a theoretical framework for SRE assessment and guidance on standards and methods of survey required to collect appropriate data.

More generally, state and federal conservation legislation provide a framework for species (and biological community) conservation that includes categories of listing. At the state level, native flora and fauna are protected under the *Biodiversity Conservation Act 2016* (BC Act) / *Wildlife Conservation Act 1950* (WC Act). The highest level of protection is given to Schedule 1 species that are considered rare, likely to become extinct, or otherwise in need of special protection. The current list of threatened species is provided by the Wildlife Conservation (Specifically Protected Fauna) Notice 2016. Parks and Wildlife (Department of Biodiversity, Conservation and Attractions) also maintains a list of priority fauna species that are of conservation importance but, for various reasons, do not meet the criteria for listing as threatened.

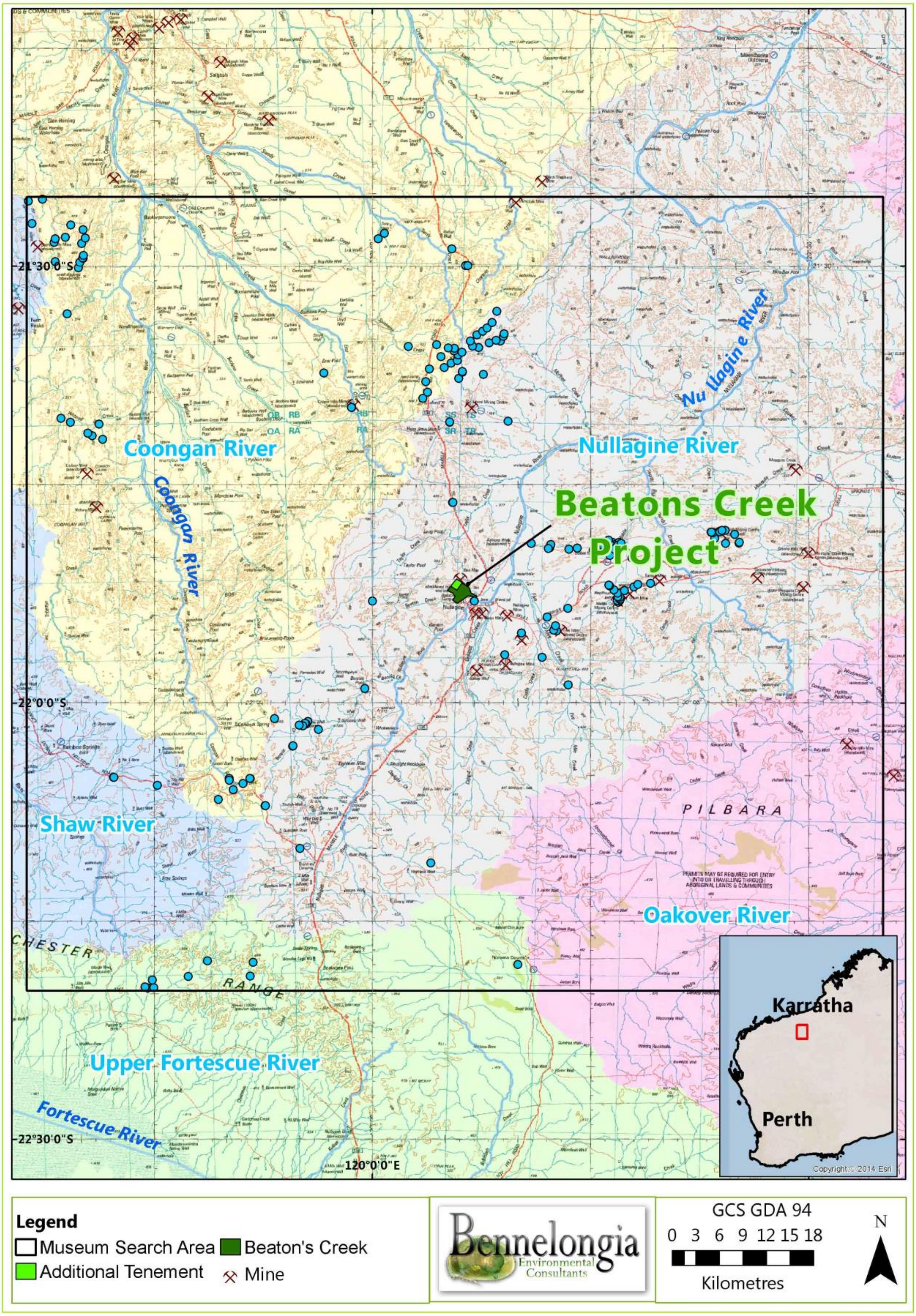

Figure 1. Location of Beatons Creek, the additional tenement and museum search results (blue circles).

In addition to protecting individual species, ecological communities may be listed as in need of special protection at both the state and federal levels. At the state level, the Minister may list a biological community as a Threatened Ecological Community (TEC) if the community is presumed to be totally destroyed or at risk of becoming totally destroyed. Where there is insufficient information for a community to be considered as a TEC, or when a community is rare but not currently threatened, it may be listed as a Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions. However, no community is currently listed as a TEC or PEC on the basis of SRE fauna.

2.2. SRE Framework

Impact assessment for SREs in Western Australia focuses on up to 11 taxonomic groups (the SRE Groups) of ground-dwelling invertebrates that are known to contain high proportions of SRE species. These are land snails (Gastropoda), millipedes (Diplopoda), centipedes (Chilopoda), symphylans (Symphyla), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), spiders (Mygalomorphae, Selenopidae and Micropholcommatidae), harvestmen (Opiliones), slaters (Isopoda), velvet worms (Onychophora) and earthworms (Megadrilacea). In Western Australia velvet worms and earthworms are confined to mesic southwestern habitats and do not occur in the vicinity of the Project. Some salt-lake specialist species of wolf spiders and tiger beetles are also considered potential SREs.

Many species belonging to SRE Groups are in fact widespread, such as the large number of habitat generalist scorpions (Smith 1995). Focus on SREs is essentially a screening process when assessing the likely impacts of a project on invertebrates, whereby assessment is restricted to a manageable number of species that have a relatively high probability of being affected by the Project. A major challenge when using this screening process, however, is determining whether species belonging to an SRE Group actually have ranges <10,000 km^2.

The principle purpose for focussing on SRE species is that they are likely to have limited occurrences beyond the vicinity of the project and loss of a population within a project area is relatively likely to have conservation implications for the species concerned. In a few cases the entire range of an SRE species may fall within an area of project disturbance, thus threatening persistence of the species. This highlights that the level of threat to an SRE species depends on the relationship between its range and the location and spatial extent of the development footprint. In the absence of very complete field sampling, factors such as the extent of the habitat in which an SRE species was collected, the size of the development footprint and the ranges of congeneric species are useful indicators of the likely threat of a project to the species.

2.2.1. Classifying SRE species

A five-tier classification scheme for SRE species was used, similar to that of the Western Australian Museum:

Confirmed SREs are species with a well surveyed range of <10,000 km^2 (or 100 km linear range).

Potential SREs are species with imperfectly understood ranges because sampling has been patchy. In some cases, the uncertainty about range is compounded by an incomplete taxonomic framework.

Unlikely SRE species include potentially new species that do not possess the traits of an SRE species (i.e. biological or habitat factors). For example, this subcategory may include species recorded during a survey from one or more habitat types that have low prospectivity for SREs or species possessing very few morphological features typical of SREs.

Not SRE species have a known range of >10,000 km^2. The taxonomy of such species should be well understood, so as not to include the ranges of multiple closely related species in the range estimate.

Unknown taxa are usually higher-level identifications (possibly due to immature or damaged specimens) or identifications of species complexes where there have been recent revisions that make it unclear what species was originally collected.

3. DESKTOP REVIEW

3.1. Habitat Assessment

Land systems mapping prepared by the Western Australian Department of Agriculture (van Vreeswyk *et al.* 2004), vegetation mapping (Beard *et al.* 2013), the Nullagine 100,000 geological map (Bagas *et al.* 2004) and satellite imagery were used to assess the suitability of habitats at the Project for SRE species. Habitats were assessed according to five criteria: the availability of moisture; soil structure; geological diversity; vegetation type; and extent of shade or shelter. The emphasis was on identifying 'relict' habitats (e.g. sheltered, moist for millipedes) and those that may contain specialist species (e.g. rocky outcrops for selenopid spiders). The extent of these habitat types beyond the Project, external habitat connectivity and the presence of habitat isolates that might restrict dispersal of SRE fauna were evaluated using broad-scale vegetation mapping (Beard *et al.* 2013). Identifying and mapping SRE habitats was based on current knowledge of the ecology of SRE invertebrates.

The Project lies on a single surface geology unit 'AFhe' that is defined as pebble to cobble conglomerate interbedded with medium to coarse sandstone; a single vegetation type 'code 173' - 'Hummock grasslands, shrub steppe; ranji (*A. pyrifolia*) over soft spinifex *T. pungens* & *T. wiseana* on basalt'; and a single land system 'RGECPN' - 'Rugged hills and ridges on sedimentary rocks; poorly accessible, not degraded or eroded' (Figure 2). Overlain with satellite imagery (Figure 3), the Project could be described as hummock grasslands over rugged hills and ridges over sedimentary rocks. The hills and ridges appear highly exposed with very few trees, shade and likely very limited litter. Unless there are significant rock piles on the hills and ridges, the Project is not prospective for SREs. Rock piles are prospective for selenopid spiders and pseudoscorpions. South-facing slopes of hills and ridges are often prospective for SREs although there is no discernible difference between the south and north facing slopes at the Project.

3.2. SRE Fauna of the Pilbara

The Pilbara is one of the oldest land surfaces on earth (Pillans 2007) and supports very diverse communities of SRE fauna (e.g. Castalanelli *et al.* 2014; Harvey 2002; Rix *et al.* 2017b). Knowledge of these communities is derived in part from surveys undertaken as part of environmental impact assessments and biological studies in the Pilbara, primarily the Pilbara Biodiversity Survey, a systematic, broad-scale survey for ground-dwelling terrestrial fauna that included four groups of invertebrates (ants, beetles, scorpions and spiders) in addition to mammals, birds, reptiles and aquatic fauna (Gibson *et al.* 2015). The general richness of the Pilbara is thought to derive from the formation of the Australian arid zone during the Neogene, which resulted in extinctions or range contractions of mesic-adapted fauna and diversification and range expansion of arid-adapted taxa (Rix *et al.* 2017a). The Pilbara Biodiversity Survey found the pattern of turnover of terrestrial fauna most strongly related to environmental variables associated with regolith, followed by landform/hydrologic and then by climate/biotic variables. Scorpions and beetles showed strong relationships with soil attributes (Gibson *et al.* 2015) and Gollan *et al.* (2009) identify soil parameters as important predictors of invertebrate assemblages in the Pilbara. Some so-called relictual groups persist only in local refugia but several other groups have undergone extensive radiations and are highly diverse at the species level (Car and Harvey 2013; Car *et al.* 2013).

Six diverse families of trapdoor spiders reliably occur in the subregion, including Actinopodidae, Barychelidae, Ctenizidae, Idiopidae, Nemesiidae, and Theraphosidae. Many of the recorded species are known only from very few specimens and localities, with small distributions, and endemism is high (Castalanelli *et al.* 2014; Harms and Framenau 2013; Main 1983, 1986, 2008; Raven 1994). Although a

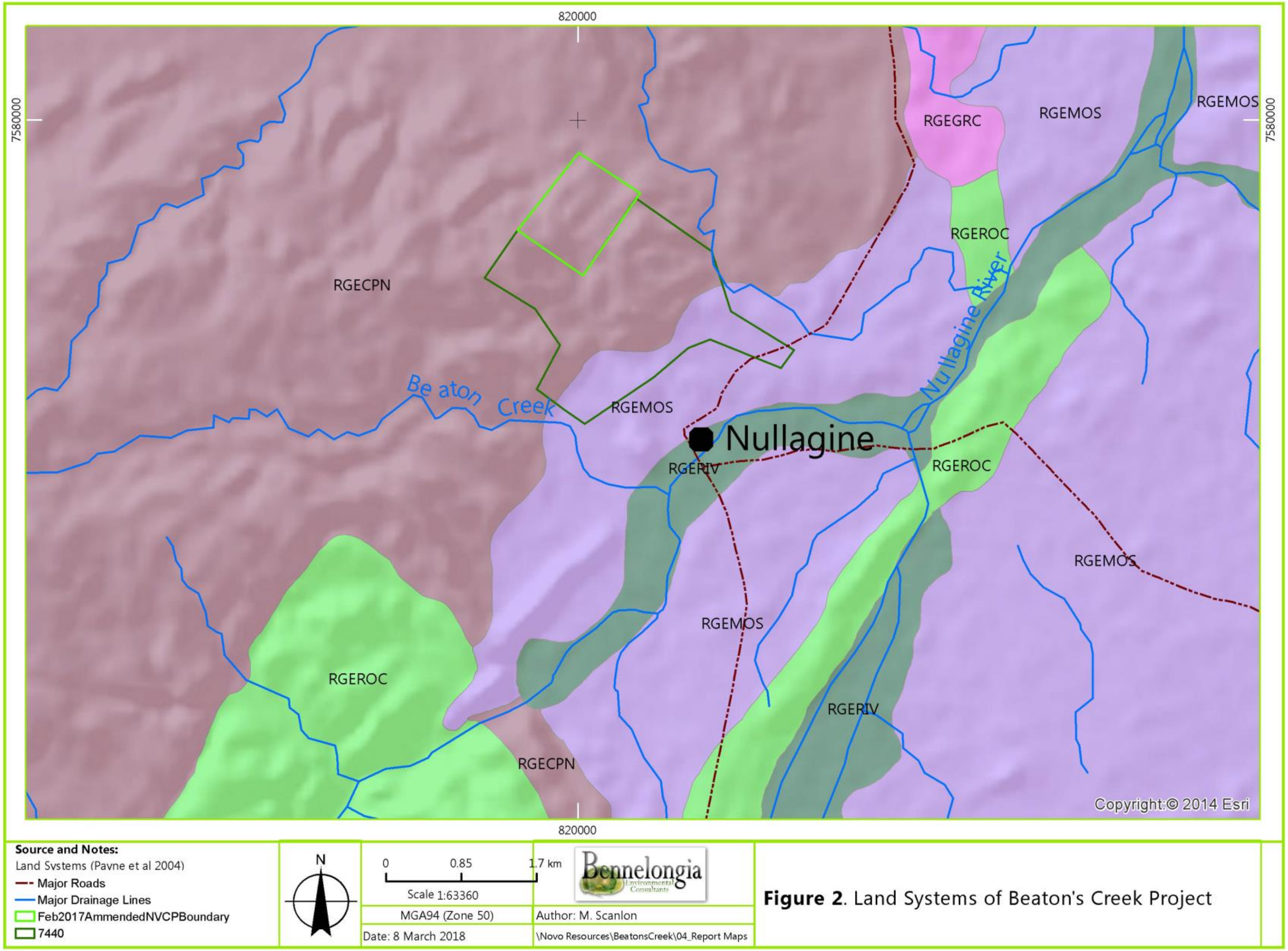

Figure 2. Land systems at Beatons Creek and the additional tenement of the Project.

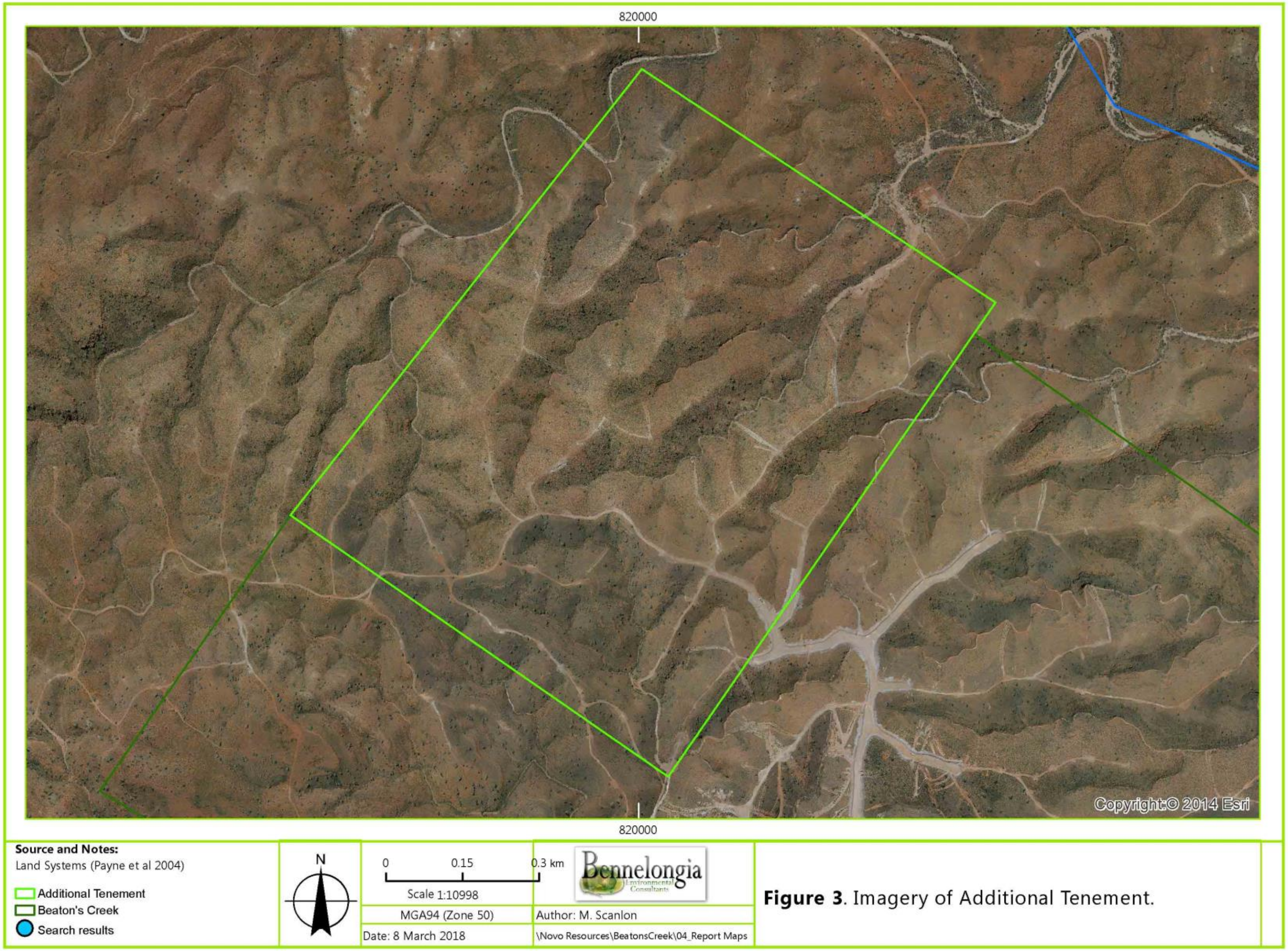

Figure 3. Imagery of the Project area (additional tenement).

few trapdoor species appear to have ranges beyond 100 km², cryptic speciation is common (Castalanelli *et al.* 2014) and all species should be treated as SREs. Some of the idiopid and barychelid genera (e.g. *Idiosoma* and *Synothele*) include dozens of species, most of which are currently undescribed (e.g. Rix *et al.* 2017b). Wall-crab spiders of the family Selenopidae are also diverse and endemic species have been collected from under rocks in isolated BIF formations and rocky ridges (Crews and Harvey 2011; Crews 2013).

The myriapod (millipede and centipede) fauna is diverse, with two genera being of conservation significance. All described species of the megadiverse genus *Antichiropus* and *Boreohersperus* are SRE species and have ranges of less than 10,000 km² (Car and Harvey 2013; Car *et al.* 2013). The centipede fauna is poorly known but the families Geophilidae and Cryptopidae are collected frequently during invertebrate surveys and contain at least some potential SREs.

Terrestrial slaters are common in woodlands, BIF formations and creekline habitats. Genera such as *Buddelundia* are megadiverse at a species level, although there is no taxonomic framework for terrestrial slaters in Western Australia and so the assessment of ranges is extremely difficult (Judd and Horwitz 2003). Slaters are collected in almost every invertebrate fauna survey in the WA and are one of the prime target groups in SRE assessments.

Terrestrial snails are also collected frequently during fauna surveys in the Pilbara. Genera from the Pupillidae family (*Gastrocopta* and *Pupoides*) contain widespread species (Whisson and Köhler 2013) but the families Camaenidae and Bothriembryontidae (the latter with many undescribed species) are extremely diverse at the species level and comprise mostly SREs (Breure and Whisson 2012; Hamilton and Johnson 2015; Köhler and Criscione 2015; Solem 1997; Stankowski and Johnson 2014; Whisson and Kirkendale 2014). The snail genus *Bothriembryon* in particular is currently the focus of systematic study and it appears that there is major diversity and endemism in this fauna. The Succineidae also occur in the Pilbara but little is known about species ranges.

Harvestmen, pseudoscorpions and scorpions occur throughout the Pilbara. Amongst scorpions, the genus *Urodacus* includes a moderately high proportion of potential SRE species because there are several species living under rocks that may be restricted to specific BIF ranges and have patchy distributions within these habitats. In contrast, the genus *Lychas* predominantly comprises widespread species on plains and open woodlands. The pseudoscorpion genera *Synsphyronus* and *Feaella* includes many range restricted species (all in the case of *Feaella*) and they live under rocks on BIFs, rocky outcrops and granites, with species of *Synsphyronus* collected from tree bark currently considered more widespread (Harvey 1987, 2012; Harvey *et al.* 2016; Harvey *et al.* 2015). Genera such as *Austrochthonius*, *Austrohorus* and *Amblyolpium* are thought to include at least some SRE species. Olpiidae pseudoscorpions are not usually regarded as SREs because they are good dispersers (Cosgrove *et al.* 2016; i.e. phoresy with flying insects) and Pilbara species appear to be highly arid adapted. Not much is known about harvestmen in the Pilbara but based on biological characteristics (moisture-dependence, restriction to leaf litter habitats) this fauna will include SREs (Harvey 2002).

In summary, the Pilbara region has a highly diverse SRE fauna at all taxonomic levels.

3.3. Previously Recorded Species Near the Project

Records of listed species and species belonging to SRE Groups were compiled from the Western Australian Museum database for a search area of approximately 100 km by 100 km surrounding the Project (defined by 21.422°S, 119.605°E and 22.331°S, 120.585°E). Published research papers, available environmental reports, Bennelongia's internal database and online resources such as the Atlas of Living Australia (ALA 2018) and the Australian Faunal Directory (ABRS 2009) were also reviewed.

Approximately 76 species from SRE Groups have been recorded in the search area (Table 1, Appendix 1). The number of species is approximate because some listed taxa may be in fact belong to the same species, while others may consist of multiple species. Nineteen (25%) of the recorded species are described, four are probably conspecific with described species, 35 are morphospecies or unpublished manuscript names and the remaining 18 taxa are higher-order identifications. Higher-order identifications were only included in the final list of recorded species if they belonged to taxonomic units that clearly comprised additional species. The SRE Groups recorded were spiders (infraorders Araneomorphae and Mygalomorphae), harvestmen (Opiliones), pseudoscorpions, scorpions, centipedes (Chilopoda), millipedes (Diplopoda), land snails (Gastropoda) and slaters (Isopoda). A summary of species recorded in the search area is given in Table 1 and the complete list of species is given in Appendix 1. A map showing the distribution of regional survey effort and recorded species is given as Appendix 2.

The search area appears to be dominated by arid-adapted fauna, with a highly diverse assemblage of pseudoscorpions and scorpions, comprising 19 and 17 species respectively. Mygalomorph spiders were moderately diverse (13 species), followed by scolopendrid centipedes (8) and slaters (7). Few species are known from the remaining groups - snails (3), polyxenid and *Antichiropus* millipedes (2 species each), soil centipedes (2), opilionids (1), scutigerids (1) and selenopid spiders (1). An important finding is that the Nullagine area appears to support fewer species than most other regions of the Pilbara, with surveys in the area producing results that matched search results. For example, east of Nullagine at projects BlueSpec and Golden Eagle, 39 and 18 species were recorded respectively (Bennelongia 2013; Rapallo 2010).

Fourteen of the species recorded in the search area have known linear ranges of less than 100 km and they comprise one species with a linear range of 77 km, three with ranges of less than 40 km and 11 singletons (only known from a single animal or location). Four species were classed potential SREs and one of these, the pseudoscorpion *Xenolpium* `PSE063`, may be an actual SRE as it is only known from south-facing ridges and steep gullies over a distance of 9.4 km. The other three species are unlikely to beSREs because they were collected in habitats not especially prospective for SREs. The remaining 10 species with linear ranges of less than 100 km were classed as unlikely to be SREs either due to their relatively large distributions, records in one or several non-prospective SRE habitats or likelihood of being conspecific with a widespread species. This includes two species of millipedes from the genus *Antichiropus* (a genus that comprises many SREs) that have ranges of 41.3 km and 77.4 km across multiple, non-prospective habitat types.

Table 1. Records of invertebrate species from SRE Groups in the vicinity of the Project.
Potential SREs are in brackets. Linear ranges cannot be calculated for higher order identifications (n/a). Locations are in reference to Nullagine.

Taxonomy	**Richness**					**Families**	**Linear Range (km)**		
	Centre	East	North	South	Total		< 100	> 100	n/a
Arthropoda									
Chelicerata									
Araneae	1	5	7	5	14	7	6 (**1**)	3	5
Opiliones				1	1	1	1		
Pseudoscorpiones		12	10	8	19	7	4 (**2**)	7	8
Scorpiones	5	7	10	7	17	2	3 (**1**)	14	
Crustacea									
Isopoda		5		2	7	2	1	4	2
Myriapoda									
Chilopoda									
Geophilida		2			2	2		2	
Scolopendrida		3		5	8	2		8	
Scutigeromorpha	1	1	1	1	1	1		1	
Diplopoda									
Polydesmida	1	1	1		2	1	2		
Polyxenida		2		1	2	2			2
Mollusca		3			3	2		**3**	
Total	**8**	**41**	**29**	**30**	**76**	**29**	**17 (4)**	**42**	**17**

3.3.1. Listed Invertebrate Species at the Project

There are no PECs or TECs in the survey area that are listed based on terrestrial SREs. No listed species occur within the search area, with the nearest species (*Antichiropus* `DIP004`, listed as Priority 1) known from Roy Hill Station to the south; this species will not occur at or near the Project.

4. CONCLUSION

The Project comprises highly exposed hills and ridges that support only hummock grasslands and are not prospective for SREs. No listed invertebrates, confirmed or potential SREs were recorded at the Project. The highly exposed, widespread and uniform nature of habitat at the Project together with museum search results suggest there is likely to be a depauperate community of terrestrial invertebrates present at the Project. There is unlikely to be any actual SRE species in the community.

The Project is small in extent (96.8 ha) and this small size, together with the non-prospective habitats and low richness of species in SRE Groups in the vicinity, makes it unlikely the Project will affect the conservation status of any SRE species in the local region. This conclusion is considered to be sufficiently robust that no field survey is required.

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Appendix 1. Records of SRE taxa in the search area.

Locations refer to the search area with 'centre' being close to Nullagine and Beatons Creek. SRE status according to definitions in Section 2.2.1. Species shaded blue are potential SREs.

Taxonomy	Lowest Identification	Centre	East	North	South	Linear Range	SRE Status	Distribution Notes
Arthropoda								
Chelicerata								
Araneae								
Araneomorphae								
Selenopidae	Karaops sp. B03		2			0 km	Potential	Known from a single, highly exposed, rocky slope
Mygalomorphae								
Actinopodidae	Missulena rutraspina			4	2	> 100 km	Not SRE	Widespread across Australia
	Missulena sp. B06		1			0 km	Unlikely	Females; collected in open plains east of Nullagine; likely to be conspecific with M. rutraspina
Barychelidae	Aurecocrypta sp.			1		Unknown	Unknown	Juvenile; only record of genus in search area
	Idiommata `MYG111`			1		> 100 km	Not SRE	Widespread (Durrant 2010). Animals of this genus are quite large and predominantly have large ranges (i.e. not SREs)
	Synothele `MYG114`			1		0 km	Unlikely	Collected in one widespread and non-prospective SRE habitat
	Synothele `MYG193`		2			23.3 km	Unlikely	Collected in one widespread and non-prospective SRE habitat
Ctenizidae	Conothele sp.				1	Unknown	Unknown	Juvenile; only record of genus in search area
Dipluridae	Cethegus sp.				2	Unknown	Unknown	Juvenile; only record of genus in search area
Idiopidae	Idiopidae sp.			1		Unknown	Unknown	Juvenile; only record of genus in search area
Nemesiidae	Aname `MYG099`			3	6	> 100 km	Not SRE	Across the eastern Pilbara
	Aname `MYG368`		1			0 km	Unlikely	Recorded in open plains east of Nullagine
	Aname mellosa	2	4	32		> 100 km	Not SRE	Widespread through the Pilbara although it comprise multiple mOTUs
	Kwonkan sp.				1	Unknown	Unknown	Juvenile; only record of genus in search area
Opiliones	Opiliones sp.				1	Unknown	Unknown	Juvenile; only record of genus in search area
Pseudoscorpiones								
Hyidae	Indohya `PSE002`		1		3	> 100 km	Not SRE	Recorded throughout the Pilbara
Atemnidae	Oratemnus sp.		4	5	4	Unknown	Unknown	Juvenile; only record of genus in search area
Chernetidae	Troglochernes sp.				1	Unknown	Unknown	Juvenile; only record of genus in search area
Garypidae	Synsphyronus `paradoxus complex`			1		Unknown	Unknown	S. paradoxus is currently under revision. The genus contains some SREs
	Synsphyronus `PSE075`		1			0 km	Potential	Only known from a minor tributary
	Synsphyronus `PSE091, 7/3 short`			2		0 km	Unlikely	Recorded in a creek surrounded by open plains
	Synsphyronus `PSE093, 8/1 Pilbara`		4			> 100 km	Not SRE	Recorded throughout the Pilbara
	Synsphyronus heptatrichus		1			> 100 km	Not SRE	Recorded throughout the Pilbara
Olpiidae	Austrohorus sp.		23	5	1	Unknown	Unknown	Juvenile; only record of genus in search area
	Euryolpium sp.		9			Unknown	Not SRE	Juvenile; only record of genus in search area
	Indolpium sp.		11	20	35	Unknown	Unknown	Juvenile; only record of genus in search area
	Linnaeolpium sp.				2	Unknown	Unknown	Juvenile; only record of genus in search area
	Olpiidae Genus 7/4 sp.			1		Unknown	Unknown	Juvenile; only record of genus in search area
	Xenolpium `PSE063`			32		9.4 km	Potential	Known from several rocky hills and gullies north of Nullagine
	Beierolpium 8/4 large		1	1		> 100 km	Not SRE	Recorded throughout the Pilbara
	Beierolpium 8/3		14	4	4	> 100 km	Not SRE	Recorded throughout the Pilbara

Taxonomy	Lowest Identification	Centre	East	North	South	Linear Range	SRE Status	Distribution Notes
	Beierolpium 8/2		1			> 100 km	Not SRE	Recorded throughout the Pilbara
Sternophoridae	Afrosternophorus sp.		1	1		Unknown	Unknown	Juvenile; only record of genus in search area
Chthoniidae	Tyrannochthonius aridus				1	> 100 km	Not SRE	Recorded throughout the Pilbara
Scorpiones								
(blank)								
Buthidae	Lychas `gracilimanus`			3	1	> 100 km	Not SRE	Recorded throughout the Pilbara
	Lychas `hairy tail group`		4	58	4	> 100 km	Not SRE	Recorded throughout the Pilbara
	Lychas `harveyi`	29		19	25	> 100 km	Not SRE	Recorded throughout the Pilbara
	Lychas `multipunctatus` ms		3			> 100 km	Not SRE	Recorded throughout the Pilbara
	Lychas `SCO023`				1	0 km	Unlikely	Recorded in open plains on Bonney Downs Station
	Lychas annulatus	5		1		> 100 km	Not SRE	Recorded throughout the Pilbara
	Lychas bituberculatus		21	48		> 100 km	Not SRE	Recorded throughout the Pilbara
Urodacidae	Urodacus `nullagine dark`		2			> 100 km	Not SRE	Across the eastern Pilbara
	Urodacus `nullagine pale`	1	2			> 100 km	Not SRE	Across the eastern Pilbara
	Urodacus `pilbara 16`			1		0 km	Unlikely	Collected in open plains near minor tributary
	Urodacus `pilbara 4`			25		> 100 km	Not SRE	Across the eastern Pilbara
	Urodacus `pilbara 5`			6		> 100 km	Not SRE	Across the eastern Pilbara
	Urodacus `pilbara 8`		13	10	8	> 100 km	Not SRE	Recorded throughout the Pilbara
	Urodacus armatus s.l.	1			15	> 100 km	Not SRE	Although known from across WA, this is likely to be a species complex
	Urodacus butleri			1	5	> 100 km	Not SRE	Across WA
	Urodacus hoplurus	1				> 100 km	Not SRE	Across WA
	Urodacus sp. B06		1			0 km	Potential	Only known from a single location alongside a minor tributary
Crustacea								
Isopoda								
Armadillidae	Acanthodillo sp.				3	Unknown	Unknown	The genus is collected across WA
	Buddelundia sp. B22 (SJ `14`)		256			> 100 km	Not SRE	Widespread in Pilbara
	Buddelundia sp. B27 (SJ `13`)		5			> 100 km	Not SRE	Widespread in Pilbara
	Buddelundia sp. B35 (SJ gen. nov. sp. nov. 03)		15			> 100 km	Not SRE	Widespread in Pilbara
	Buddelundia sp. B36 (SJ `11`)		51			> 100 km	Not SRE	Widespread in Pilbara
	Buddelundia sp. B37 (SJ `sp. nov.`)		3			0 km	Unlikely	Only known from one location in open plains
Philosciidae	Laevophiloscia sp.				26	Unknown	Unknown	The genus is collected across WA
Myriapoda								
Chilopoda								
Geophilida								
Chilenophilidae	Sepedonophilus sp. B01		3			> 100 km	Not SRE	Throughout the Pilbara
Schendylidae	Australoschendyla capensis		3			> 100 km	Not SRE	Throughout the Pilbara
Scolopendrida								
Cryptopidae	Cryptops nr spinipes		4			> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
Scolopendridae	Arthrorhabdus nr mjobergi		2			> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
	Arthrorhabdus paucispinus				1	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
	Cormocephalus turneri				44	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
	Cormocephalus westangelasensis		1			> 100 km	Not SRE	Throughout the Pilbara. Surface species of this family are not SREs

Taxonomy	Lowest Identification	Centre	East	North	South	Linear Range	SRE Status	Distribution Notes
	Ethmostigmus curtipes				4	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
	Scolopendra laeta				30	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
	Scolopendra morsitans				124	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
Scutigeromorpha								
Scutigeridae	Pilbarascutigera incola	7	4	3	5	> 100 km	Not SRE	Across Australia. Surface species of this family are not SREs
Diplopoda								
Polydesmida								
Paradoxosomatidae	Antichiropus `DIP026`	6		32		41.3 km	Unlikely	Collected in three widespread and non-prospective SRE habitats
	Antichiropus `DIP032`		19			77.4 km	Unlikely	Collected in multiple, widespread, non-prospective SRE habitats
Polyxenida								
Polyxenidae	Polyxenidae sp.		5		1	Unknown	Not SRE	No surface Polyxenids are SREs. Likely to be one of the described and widespread Unixenus species
Synxenidae	Synxenidae sp.		15			Unknown	Not SRE	No surface Polyxenids are SREs. Likely to be one of the described and widespread Phryssonotus species
Mollusca								
Gastropoda								
Pupillidae	Gastrocopta hedleyi		31			> 100 km	Not SRE	Throughout across northern Australia. The family is not considered to contain SREs
	Pupoides aff. beltianus		24			> 100 km	Not SRE	Throughout across central Australia. The family is not considered to contain SREs
Subulinidae	Eremopeas interioris		1			> 100 km	Not SRE	Throughout central Australia. The family is not considered to contain SREs

Appendix 2. Records of Higher Order SRE taxa in the search area.

Taxonomy	Lowest Identification	Centre	East	North	South	Notes
Arthropoda						
Chelicerata						
Araneae						
Mygalomorphae						
Actinopodidae	Missulena sp.	1				
Barychelidae	Barychelidae sp.	1		4		
	Synothele sp.		1			
Nemesiidae	Aname sp.		5	3		
	Nemesiidae sp.	1	1	4		
Pseudoscorpiones	Pseudoscorpiones sp.				13	
Garypidae	Garypidae sp.		6			One of the Synsphyronus species
Olpiidae	Beierolpium sp.		8			
	Olpiidae sp.			1	1	
	Xenolpium sp.		22	32		Possibly `PSE063`
Scorpiones	Scorpiones sp.		3	29	1	
Buthidae	Buthidae sp.				15	
	Lychas sp.			21		
	Lychas sp. 1			2	7	Collected in the Pilbara Biological Survey and likely represented by one of the species above
	Lychas sp. 3		4	11		
	Lychas sp. 4	4	2	48	4	
	Lychas sp. 6	1		6		
Urodacidae	Urodacus sp. 2			2		
	Urodacus sp. 4	1				
	Urodacus sp.		1	5	1	
Crustacea						
Isopoda	Isopoda sp.				45	
Armadillidae	Buddelundia sp.		2		456	
Myriapoda						
Chilopoda	Chilopoda sp.				3	
Scolopendrida						
Cryptopidae	Cryptopidae sp.				6	
Scolopendridae	Cormocephalus nr turneri		3			Probably C. turneri
	Cormocephalus sp.		1			
	Scolopendra nr laeta		1			Probably S. laeta
	Scolopendra nr morsitans		3			Probably S. morsitans
	Scolopendrinae sp.		1			
Scutigeromorpha						
Scutigeridae	Parascutigera sp.			1		
	Pilbarascutigera nr incola		1			Probably P. incola
	Pilbarascutigera sp.	3	4			
Diplopoda						
Polydesmida						
Paradoxosomatidae	Antichiropus sp.	1	10	16	10	

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