FERRAUS PILBARA PROJECT

SUBTERRANEAN FAUNA SURVEY STRATEGY

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FERRAUS LIMITED
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Contents

1 INTRODUCTION

1.1 DOCUMENT PURPOSE AND SCOPE

This Subterranean Fauna Survey Strategy (SFSS) has been developed for the FerrAus Pilbara Project (FPP). The aim of the SFSS is to conduct sufficient additional surveys considered as necessary to determine whether mine operations are likely to pose a threat to the persistence of any subterranean fauna species.

The specific objectives of the SFSS are to:

- collect additional species diversity in the FPP project area, consistent with the requirements of Guidance Statement 54a (EPA 2007)
- search for species of interest outside of the proposed FPP impact areas that have previously only been recorded inside impact areas
- identify suitable habitat for species of interest outside of proposed impact areas
- assess the level of potential impacts of the FPP on subterranean fauna.

The SFSS applies to the following FPP components:

- Robertson Range Area (RRA)
- Davidson Creek Area (DCA)
- regional sampling locations surrounding RRA and DCA.

1.1.1 Version information

This version has been prepared to accompany the Assessment on Proponent's Information document.

1.2 BACKGROUND

The following information is provided as an overview for the purposes of supporting the content of the SFSS. For detailed descriptions of the FPP, environmental surveys and other environmental management measures, the main project referral documents should first be consulted as a guide.

1.2.1 Subterranean fauna

Subterranean fauna are fauna, predominantly invertebrates that live within air- or water-filled underground networks. Organisms specialised for living in air-filled subterranean networks are referred to as troglofauna, while those inhabiting water-filled subterranean networks are referred to as stygofauna (Howarth 1983; Humphreys 2000).

Troglofauna are typically divided into three categories of specialisation to subterranean life:

- troglobites, that are restricted to subterranean habitats and usually perish on exposure to the surface environment (Barr 1968; Howarth 1983; Humphreys 2000)
- troglophiles, which facultatively use subterranean habitats but are not reliant on them for survival (Barr 1968; Howarth 1983; Humphreys 2000)
- trogloxenes, which use subterranean systems for specific purposes, such as roosts or reproduction (Bats and Swiftlets) (Barr 1968; Howarth 1983; Humphreys 2000).

Troglofauna of conservation value are comprised of troglobites and troglophiles with short-range endemism prevalent in both categories (Harvey 2002).

Stygofauna represent the fauna living within subterranean water bodies or aquifers (Humphreys 2000). They typically show similar traits to troglobites in their specialisation to subterranean life, including loss of body pigment, eyes and heightened mechanosensory systems. Stygofauna are similarly classified into:

- stygobites, that are restricted to subterranean habitats and usually perish on exposure to the surface environment (Humphreys 2008)
- stygophiles, which facultatively use subterranean habitats but are not reliant on them for survival (Humphreys 2008)
- stygoxenes, that are surface species that move between surface and subterranean water systems where connectivity occurs (Humphreys 2000).

Stygofauna of conservation value (short-range endemic species) are mostly comprised of stygobitic species.

1.2.2 Previous surveys

The following subterranean fauna surveys have been undertaken for the FPP since 2008 in accordance with Environmental Protection Authority (EPA) Guidance Statement 54a (EPA 2007):

1. Phoenix Environmental Sciences (Phoenix 2011) Subterranean Fauna Survey of the FerrAus Pilbara Project: Mirrin Mirrin and Tiger/Dugite. This survey was completed over three phases representing two seasons (January 2011, March 2011 and April 2011) and comprised bore scraping, stygofauna netting and troglofauna trapping of the Mirrin Mirrin, Dugite and Tiger pits in the Davidson Creek mine area. The survey also included regional surveying, targeting creeks and a series of survey bores in a previous mining area (Brockman).
2. Phoenix Environmental Sciences (Phoenix 2009a) Python and Gwardar Iron Ore Deposit Stygofauna Survey Final Report: FerrAus Pilbara Project. This study comprised three phases of sampling (November 2008, March 2009 and March 2010) of 69 bores within and surrounding the Python and Gwardar mine deposits.

3. Phoenix Environmental Sciences (Phoenix 2009b) Python and Gwardar Iron Ore Deposit Troglofauna Survey Final Report: FerrAus Pilbara Project. This study comprised three phases of sampling (November 2008, March 2009 and March 2010) of 133 drill holes within and surrounding the Python and Gwardar mine deposits.
4. Ecologia (2009a) Robertson Range Subterranean Invertebrate Survey Stygofauna. This study comprised three phases of sampling (September 2007, January 2008 and March 2008) of 30 bores (achieving a sample size of 50).
5. Ecologia (2009b) Robertson Range Subterranean Invertebrate Survey Troglofauna. This study comprised sampling of 86 drill holes within and outside the impact area over three phases (September 2007, January 2008 and March 2008).

The outcomes of these surveys are presented in section 1.3, which describes the subterranean species of interest for the FPP. The previous surveys included recommendations for additional sampling for species of interest. The SFSS will address these recommendations.

1.2.3 Previous troglofauna habitat monitoring program

This strategy supersedes the previously planned troglofauna habitat monitoring program developed for the FPP following advice from the Department of Environment and Conservation (DEC) in 2009 and subsequent consultation with the DEC Environmental Management Branch in April 2010 (Anthea Jones and Bradley Durrant).

Additional subterranean fauna surveys conducted subsequent to the development of this plan have provided additional information on the subterranean fauna assemblage within the FPP project area. Hydrogeological modelling conducted in 2010 and 2011 has provided estimated drawdown contours for groundwater extraction, enabling an impact assessment to be conducted for subterranean fauna.

1.3 SPECIES OF INTEREST

The species of interest to the FPP are those species considered to be likely or potential SREs that have, to date, only been recorded from within proposed impact areas. These species are the target species of the SFSS and are discussed below.

The impact area has been defined based on the proposed areas where direct removal of habitat (i.e. the mine pits) and significant groundwater drawdown (>10 m used for preliminary screening purposes) will occur (section 1.4). The FPP environmental referral describes the species of interest in detail.

Troglobitic species of interest to the FPP are:

- Japygidae sp. PG1 – recorded only from Python/Gwardar deposit

- *Tyrannochthonius* sp. DC4 – recorded only from Tiger/Dugite deposit
- *Cryptops* sp. DC10 – recorded only from Tiger/Dugite deposit
- *Troglarmadillo* sp. DC5 – recorded only from Mirrin Mirrin deposit
- Parajapygidae sp. DC12 – recorded only from Mirrin Mirrin deposit
- Japygidae sp. DC14 – recorded only from within the >10 m drawdown contour for Mirrin Mirrin and Tiger/Dugite.
- Oniscoidea sp. (Ecologia 2009b) – recorded only from King Brown deposit and >10 m drawdown at RRA.
- Thysanuran sp. (Ecologia 2009b) – recorded only from within the >10 m drawdown contour at RRA.

With regard to the isopod *Troglarmadillo* sp. DC5, another isopod specimen (Oniscoidea sp.) was recorded from Robinson Range in 2009 and may represent a species of *Troglarmadillo*. It is possible the two species are conspecific; however, species comparisons have not been possible because the material from Robinson Range was not available for genomic analysis. The records of the remaining troglobitic species are currently restricted to only one or two specimens.

Stygofauna species of interest to the FPP are:

- *Fierscyclops* (*Pilbaracyclops*) sp. 'DC' – recorded only from Python/Gwardar deposit at DCA
- *Parastenocaris* sp. B9 – recorded only from within modelled drawdown contour >10 m at DCA
- *Pygolabis* sp. DC11 – recorded only from within modelled drawdown contour >10 m at DCA.
- Amphipoda sp. (Ecologia 2009a) – recorded only from King Brown deposit and >10 m drawdown contour at RRA.

Records of all three DCA stygofauna species are limited to only one specimen. The RRA stygofauna records are of a single species from three different bores (Ecologia 2009a). The RRA amphipods may be the same species as a more widely distributed species found at DCA (Phoenix 2009a, 2011); however the identifications still require confirmation.

Records of species of interest in relation to the proposed FPP disturbance areas are shown in **Figure 1**.

1.4 SUBTERRANEAN FAUNA HABITATS

The extent of habitat for the above species of interest to the FPP within and outside impact areas is not known. For many of the species, records to date are confined to one or two specimens making determinations about habitat extent impossible.

The specific geological formation supporting troglofauna is unclear. In most instances the Marra Mamba formation is below water level and so the air filled voids in which the troglobitic species occur is within the overburden, which is mostly comprised of alluvial sediments. Where the Marra Mamba formation extends above water table, it may represent the, or part of the, habitat in which troglofauna reside. The host aquifer for stygofauna occurs within the Marra Mamba resource; however, the distribution of recorded stygofauna also extends beyond the Marra Mamba resource, indicating that the aquifer is not completely bound by the Marra Mamba.

Determination of habitat extent for subterranean fauna is challenging and it may not be possible to clearly define habitat boundaries for species of interest to the FPP. The SFSS will therefore aim to demonstrate the presence of suitable habitat for species of interest outside the impact areas and connectivity of habitat between impact and non-impact areas.

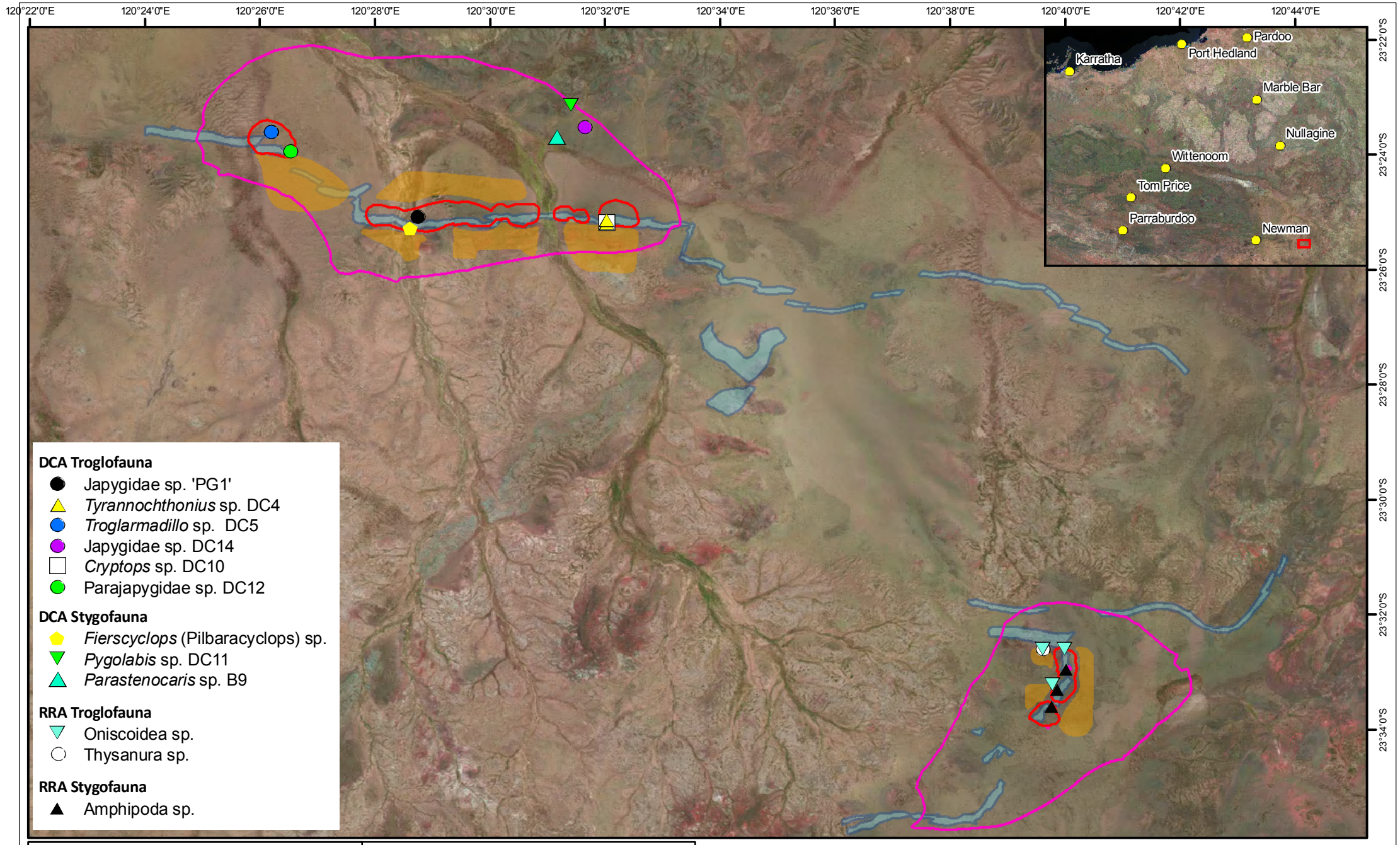

Figure 1
Species of interest records in relation to FPP impact areas

PHOENIX ENVIRONMENTAL SCIENCES

Author: ES Volschenk	CLIENT: FerrAus Ltd
DATE: 16 August 2011	Scale: 1:153,434
Coordinate System: GCS: GDA94; Datum: GDA 1994	PROJECT: FerrAus Pilbara Project

0 1.25 2.5 5 7.5 Kilometers

1.5 IMPACTS TO SUBTERRANEAN FAUNA

As described in the environmental referral, the FPP has the potential to impact on subterranean fauna. The following summary is provided for the purposes of informing the survey plan.

Impacts to subterranean fauna can be classed as either:

1. **primary impacts** - impacts that physically destroy the subterranean void networks, or
2. **secondary impacts** - impacts that change the subterranean habitat without physically destroying the void networks.

Two sources of primary impact have been identified from the FPP: development of mine pits, and depletion of the aquifer. There is also the potential for the FPP to have secondary impacts via nutrient starvation, vibration and contamination. These secondary impacts affect the physicochemical properties of subterranean habitats; the nature of the changes can be difficult to measure and there is limited empirical evidence to support or refute these putative impacts.

1.5.1 Mine pits (habitat removal)

Excavation of the mine pits will result in the loss of troglofauna habitat which occurs in the overburden. In addition, excavation of the saturated Marra Mamba iron ore resource will result in the loss of stygofauna habitat.

1.5.2 Depletion of the Marra Mamba aquifer

Significant pit dewatering is required to access the Marra Mamba resource. The extent of proposed pit dewatering is likely to have a significant effect on the aquifer and therefore impact to stygofauna. Dewatering is also likely to impact troglofauna habitat in unsaturated strata above the water table due to changes in humidity.

The EPA typically considers a lowering of the water table by more than 10 m to be a significant impact. The project requires dewatering that is likely to lower the water table by 180 m at its deepest point.

1.5.3 Nutrient starvation

Surface vegetation is the primary source of nutrients entering subterranean systems. Large-scale clearing of vegetation is likely to result in the localised nutrient starvation of underlying subterranean habitat. Smothering of these nutrient sources on which subterranean systems depend, in the form of waste and overburden stockpiles and tailings ponds, is likely to have detrimental effects to vital resources for subterranean fauna.

1.5.4 Vibration

The most likely source of vibration is from explosive blasting. Propagation of shock waves through subterranean strata from blasting or heavy vehicle traffic may result in the collapse of less-consolidated void spaces and also impact physically on subterranean fauna. There is, however, little data to challenge or corroborate these observations and these types of impacts would generally be localised rather than critically threatening.

1.5.5 Contamination

The most likely source of contamination of subterranean habitats is by liquid contaminants. The most likely contaminant risk from mine sites is diesel fuel. This risk may be significantly reduced by appropriately locating and bunding fuel depots. Placement and engineering of environmentally responsible fuel storage is standard practice on contemporary mine sites. Therefore, the risk of spills occurring that would impact on subterranean fauna is likely to be minor.

2 FRAMEWORK FOR SURVEY AND MANAGEMENT PRIORITIES

2.1 SUBTERRANEAN FAUNA SURVEY PLAN

Within six months following the formal authority issued to the decision-making authorities under section 45(7) of the *Environmental Protection Act 1986* regarding the FPP proposal:

- a Subterranean Fauna Survey Plan will be prepared in accordance with the requirements of the Minister for the Environment on advice of the EPA and the DEC
- surveys for subterranean fauna will be commenced in accordance with the Subterranean Fauna Survey Plan.

The Subterranean Fauna Survey Plan will outline procedures and measures to:

- survey areas likely to be impacted by the FPP
- survey areas with similar habitats outside the areas likely to be impacted by the FPP.

2.1 MANAGEMENT RESPONSE IN THE EVENT OF UNAVOIDABLE IMPACTS TO SUBTERRANEAN FAUNA

In the event that the results of the surveys indicate that there is a risk of loss of subterranean species or communities as a result of the FPP:

- a Subterranean Fauna Management Plan will be prepared in accordance with the requirements of the Minister for the Environment on advice of the EPA and the DEC
- management measures will be implemented in accordance with the Subterranean Fauna Management Plan.

3 DEVELOPMENT OF SUBTERRANEAN FAUNA SURVEY PLAN

The Subterranean Fauna Survey Plan will be developed prior to undertaking any further surveys. The plan will outline detailed sampling methods, survey effort, target survey locations aimed at the species listed in section 1.3 and proposed timing for conducting surveys. These aspects are discussed further below.

The plan will be consistent with EPA Guidance Statement 54a (EPA 2007), as appropriate.

3.1.1 Sampling methods

The methods outlined in the Subterranean Fauna Survey Plan will aim to address the following objectives of the SFSS:

- collect additional species diversity in the FPP project area, consistent with the requirements of Guidance Statement 54a (EPA 2007)
- locate species of interest outside of the proposed FPP impact areas that have previously only been recorded inside impact areas
- identify suitable habitat for species of interest outside of proposed impact areas.

Field survey methods will comprise:

- Net hauls for stygofauna
- Bore scraping for troglofauna
- Karaman-Chappuis sampling to provide regional data and possibly pick up some target species.

Genetic analysis of collected specimens will be undertaken, as required to determine conspecificity with target species.

Following the collection of addition species records, biological, geological and hydrogeological data will be analysed to interpret local habitat extents for species of interest. Where habitat extent mapping is not possible, emphasis will be on demonstrating presence of suitable habitat outside of impact areas, and connectivity of habitat between impact and non-impact areas.

3.1.2 Survey effort

Guidance Statement 54a (EPA 2007) indicates that, while surveys should aim to collect 95% species diversity within an area to be impacted on; it recognises that repetitive sampling until this percentage is reached is open-ended and ignores the logistics of field work and project timelines. In order to best achieve the 95% species diversity target and in a manner that is also reasonably compatible with the prior limitations, an iterative survey approach will be undertaken, involving up to three survey cycles.

Based on the apparent rarity of recorded species, an intensive sampling effort will be employed in each survey round to maximise the likelihood of achieving the 95% species diversity target.

3.1.3 Target locations

Sampling will be conducted within and outside FPP disturbance areas to collect additional species diversity and target the species of interest to the FPP. The target stygofauna are not confined to the Marra Mamba aquifer so sampling for these species will target sites both within and outside the aquifer. Sampling will target any areas likely to contain coarse gravels and cavern bearing rock strata. The sampling locations will be determined after further assessment of existing information.

For the troglofauna species of interest, it is not possible to develop a sampling plan based on target geologies due to the paucity of specimens (only one or two records per species). Some potential target areas for future surveys have been identified instead on the basis of elevation and surface geology (**Figure 2**).

Sampling will be conducted within the King Brown deposit at Robinson Range with the objective of collecting further specimens of the troglobitic isopod species, Onicidea sp.

3.1.4 Survey timing

The timing for conducting the surveys will take into consideration:

- the FPP development timeline – adequate surveys for each pit to completed prior to development of that respective pit
- optimal seasonal timing for troglofauna an stygofauna surveys, i.e mid–late summer (wet season).

3.2 HABITAT ASSESSMENT

The Subterranean Fauna Survey Plan will also describe a program for characterising and mapping the discrete subterranean fauna habitats with the study area. The use of habitat as a surrogate for predicting the distribution of biological organisms, including short range endemics, is well established (e.g. EPA 2009, Ferrier & Watson 1997). In addition to regional and local geological information, hydrogeological data such as water quality, will be used to identify habitats, particularly those that might be restricted and/or support a unique assemblage of subterranean fauna.

The development of a system for characterising and mapping potential habitats will also benefit the subterranean fauna surveys by directing efforts towards those habitats known to support the species of interest to the study.

3.2.1 Humidity dependency test (outside of FPP)

There is currently no published empirical evidence that dewatering results in an impact on humidity dependant troglofauna; although the idea appears to be logically sound. In order to test this theory, a survey of dewatered mines may be undertaken. In order to obtain sufficient data from which conclusions can be derived, access to several (ideally three) mine sites would be needed, from which survey bores are available that:

- have good baseline troglofauna data with which to compare results
- are in areas with >10 m of drawdown.

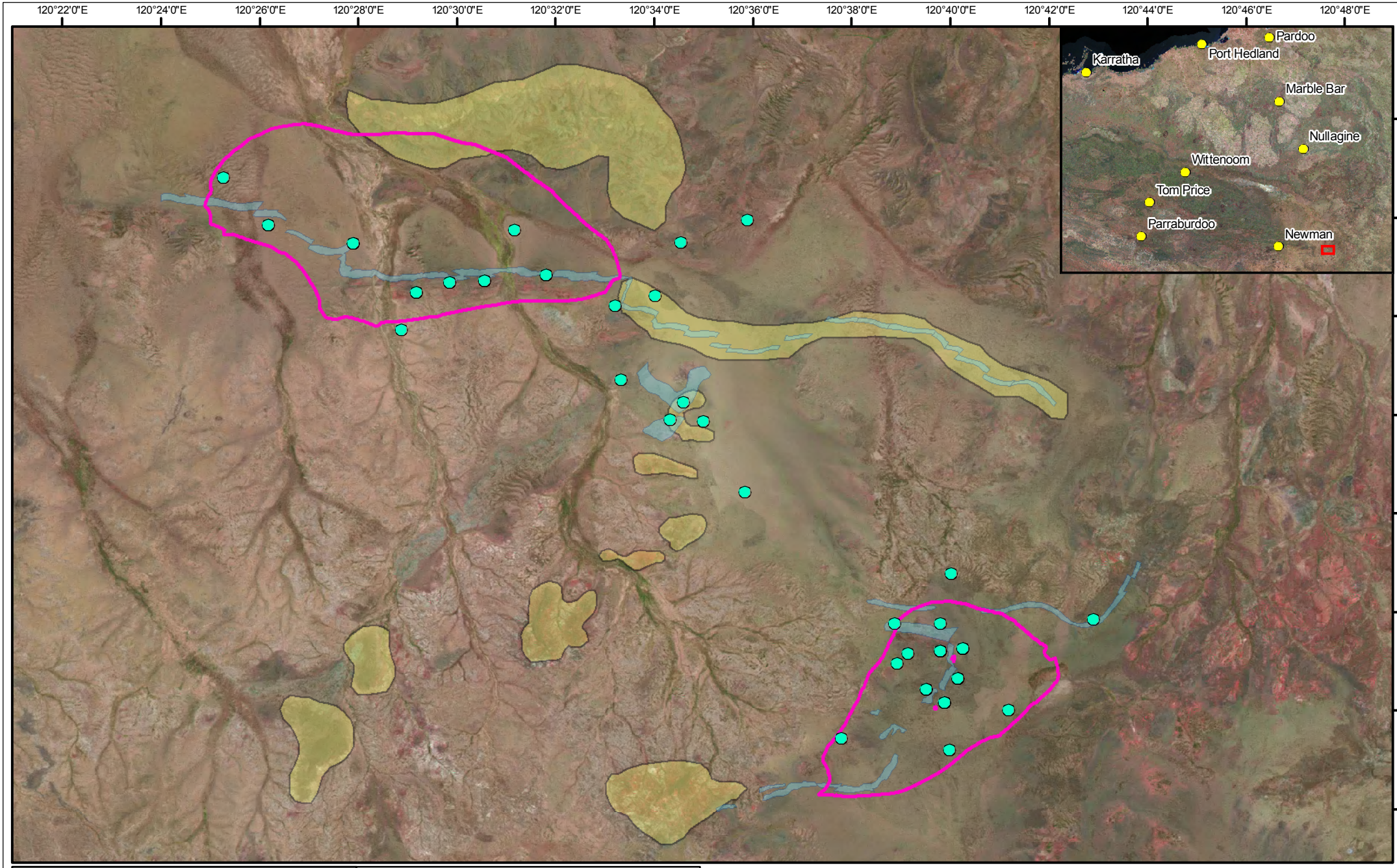

Figure 2
Potential target areas for future surveys and monitoring

PHOENIX ENVIRONMENTAL SCIENCES

Author: ES Volschenk	CLIENT: FerrAus Ltd
DATE: 9 August 2011	Scale: 1:184,634
Coordinate System: GCS: GDA94; Datum: GDA 1994	PROJECT: FerrAus Pilbara Project

0 1.5 3 6 9 Kilometers

Cluster Well
Drawdown >10 meters
Marra Mamba Formation
Target troglofauna survey areas

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