Invertebrate Solutions

1st July 2021

Dr Tim Moulds
Director Invertebrate Solutions Pty Ltd
PO Box 14
Victoria Park, WA 6979
Reference: 2021ISJ10-F01-20210701

Preliminary Assessment of subterranean fauna species habitat for the Bellevue Gold Project, Northern Goldfields region, Western Australia.

Attention Siobhan Pelliccia
Director
Blueprint Environmental Strategies Pty Ltd

Dear Siobhan

Invertebrate Solutions Pty Ltd (Invertebrate Solutions) was requested by Blueprint Environmental Strategies Pty Ltd (Blueprint) to provide a preliminary assessment for the presence of conservation significant subterranean invertebrates and communities, as well as the likelihood of suitable habitat for subterranean fauna for the Bellevue Gold Project, located approximately 40 km NW of the Leinster townsite in the Northern Goldfields region of Western Australia.

This technical memorandum is not intended to replace or act in the place of a complete desktop assessment for subterranean fauna but serves as a preliminary assessment of records held by the Western Australian Museum (WAM) and the Department of Biodiversity Conservation and Attractions (DBCA). This preliminary assessment also uses the limited water quality data from previous mining operations at the site and core photos from four diamond core holes within the Bellevue Gold Project area to undertake an assessment of the suitability of habitat to contain obligate subterranean species.

Conservation Significant Subterranean Fauna and Habitats

A list of conservation significant fauna subterranean invertebrate fauna for the Desktop Study Area was compiled from the DBCA Wildlife Conservation (Specially Protected Fauna) Notice 2019 (DBCA 2019) and the DAWE's Protected Matters Search Tool (PMST). Subterranean species that are listed under the BC Act and/or the EPBC Act and are likely to occur or have known habitat within the Desktop Study Area are shown in Table 1 along with their conservation code. The PMST results listed no known subterranean fauna within the Desktop Study Area.

Table 1 Conservation significant invertebrates potentially within the Desktop Study area.

Higher Classification	Genus and Species	DBCA/ BC Status	EPBC status	Habitat/Distribution within Desktop Study Area
Crustacea				
Isopoda: Oniscoidea	*Paraplatyarthrus subterraneus*	P1	-	Not present (Only occurs in Laverton Calcrete PEC)

Two stygofauna communities, both listed as Priority 1 Ecological Communities are known to occur in the region (Table 2). Both these calcretes were listed due to the presence of stygobiont Dytiscid diving beetles and other stygofauna species that occur in virtually every calcrete in the Yilgarn (Cooper et al. 2002; Humphreys 2008; Watts and Humphreys 2004; Watts and Humphreys 2006), and although these species make up only some of the stygobiontic fauna there is often little known of the rest of the community for the majority of sites. The presence of the conservation significant aquatic subterranean isopods in the northern Goldfields was only recognised in 2017 (Javidkar et al. 2017). The dytiscid diving beetles do not show in the searches of Western Australian Museum databases as the Entomological collection is largely un-databased and not available for searches.

Table 2 Stygofauna conservation significant communities

Calcrete Name	Community Name	Conservation listing	Buffer (m)	Distance from Bellevue Gold Project (km)
Lake Miranda East Calcrete	Lake Miranda East calcrete groundwater assemblage type on Carey palaeodrainage (Yakabindie Stn)	Priority 1	2000	0
Yakabindie Calcrete	Yakabindie calcrete groundwater assemblage type on Carey palaeodrainage (Yakabindie Stn)	Priority 1	2000	2

Stygofauna WAM Search

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2021a) and Arachnids/Myriapods (WAM 2021b). The desktop study area comprised a rectangle of approximately 330,000 ha bounded by the north west corner (27.405675°S, 120.234865°E) and the south east corner (27.920760°S, 120.826692°E) centred on the Bellevue Gold Project. The results of these filtered for subterranean stygofauna species are summarised in Table 3.

Table 3 Stygofauna recorded from the Desktop Study Area.

Higher Classification	Family	Genus and Species	Notes
Crustacea:			
Bathynellecea	Parabathynellidae	*Atopobathynella sp. 'OES8'*	Mt Keith
Copepoda	Cyclopoidae	*Mesocyclops brooksi*	Widespread
Isopoda	Oniscoidea	*Paraplatyarthrus pallidus*	Endemic to Lake Miranda East and West Calcretes
Ostracoda		sp. indet.	Mt Keith

All the stygofauna that is recorded in WAM databases in the vicinity of the Bellevue Gold Project is from calcrete outcrops including Miranda East and Miranda West calcretes. These species are endemic to their calcrete aquifers and form part of diverse and relatively abundant stygofaunal communities comprising of stygobiontic Dytiscid diving beetles that originally lead to these calcretes being declared Priority Ecological Communities. Much of the other stygofaunal diversity remains undescribed.

It should be noted that only WAM records from the Arachnida/Myriapoda, and Crustacean databases are available to determine subterranean species and does not include records of Insects (i.e. Stygobiontic diving beetles) as the WAM Insect database is unavailable for database searches.

The absence of stygofauna records from outside of calcrete geology in the Bellevue area would suggest that stygofauna habitat, and therefore stygofauna is generally absent or present in very low abundance, although it is unknown what sampling intensity has previously been undertaken and it may be due to a paucity of sampling.

Troglofauna WAM Search

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2021a) and Arachnids/Myriapods (WAM 2021b) and results present in Table 4.

The limited troglofauna diversity that is recorded in WAM databases is from the Yakabindie and Miranda West calcretes. Although the absence of troglofauna records from outside of calcrete geology would suggest that troglofauna is generally absent or present in very low abundance, it is unknown what sampling intensity has previously been undertaken and it may be due to a paucity of sampling.

Table 4 Troglofauna recorded from the Desktop Study Area.

Higher Classification	Family	Genus and Species	Notes
Arachnida:			
Pseudoscorpiones	Chthoniidae	*Tyrannochthonius* sp.	Lake Miranda West Calcrete
Cephalostigmata: Symphla		*sp. indet.*	Possibly edaphophile

Stygofauna habitat availability

Extremely limited stygofauna records are present within the WAM database records, with most of the records associated with calcrete aquifers outside of the Bellevue Project area.

The groundwater within the Bellevue Project area is mostly saline to hypersaline ranging in salinity from 17,900 mg/L TDS up to 155,000 mg/L in the Vanguard pit, further reducing the likelihood that stygofauna are present within the local aquifers. Although stygofauna have occasionally been recorded in hypersaline groundwater (up to 35,000 mg/L TDS), this has mostly been associated with aquifers at the edges of salt lakes and the majority of hypersaline waters have not been found to contain stygofauna.

Core photos examined for the saturated zone confirm the general absence of suitable fracturing that provides interconnected void space in the rock strata that may provide habitat for stygofauna (Plate 1). The likelihood of stygofauna being present is considered to be Low to Nil based upon the presence of tight unfractured volcanic strata and an absence of other nearby stygofauna records in this geology.

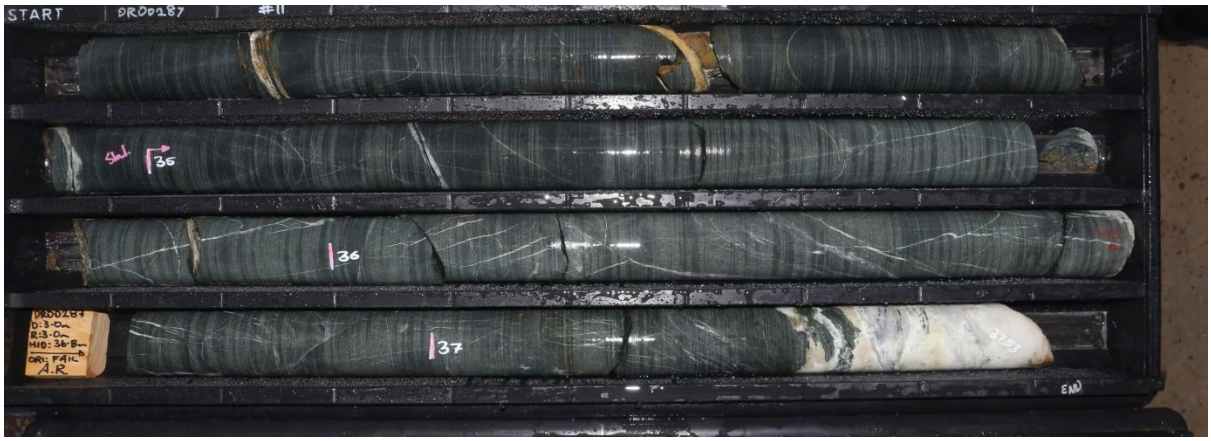

Plate 1 The absence of fracturing in core below the water table shows Low or Nil stygofauna habitat potential.

Troglofauna habitat availability

Extremely limited troglofauna has been recorded from within the Desktop Study Area in databased WAM records. The single record of a pseudoscorpion is from Calcrete outside of the Bellevue project area and no troglofauna has been recorded from within the Bellevue Project area.

The overlaying colluvium, known as the Mesovoid Shallow Substratum (MSS) is virtually un-sampled, but is increasingly known worldwide to contain significant troglobiont communities (Ortuño 2013); however, the sand and soil dominated nature of this colluvium makes the likelihood low that it will contain troglofauna in this particular area.

Core photos examined for the upper non-saturated zone confirm the absence of suitable fracturing that provides interconnected void space in the upper rock strata that may provide habitat for troglofauna. The alluvium and colluvium deposits surrounding and within the majority of the Project area have a low suitability

for troglofauna habitat, due to the fine silty nature of the alluvium that also infills any minor voids or fractures (Plate 2). The likelihood of troglofauna being present is considered to be Low to Nil based upon the presence of fine silty clay and an absence of other nearby troglofauna records in this geology.

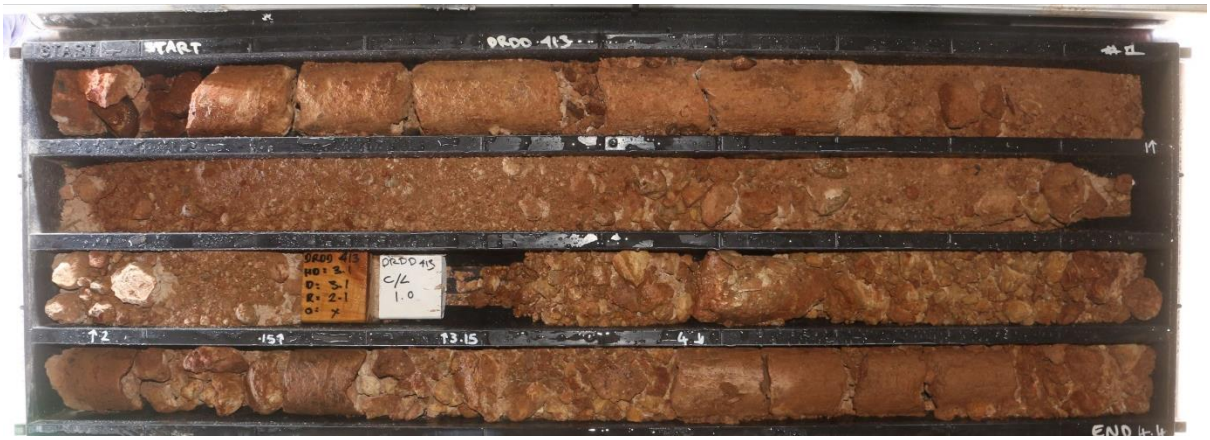

Plate 2 Clay dominated non-saturated zones or unfractured volcanic strata (Plate 1) shows Low or Nil troglofauna habitat potential.

Limitations and Exclusions

This preliminary assessment was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein. This technical memorandum is not intended to replace or act in the place of a complete desktop assessment for subterranean fauna but serves as a preliminary assessment only and further investigation or data may change the conclusions therin.

The opinions, conclusions and any recommendations in this report are based on information available, including published species distribution records and reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

References

Cooper, S. J. B., Hinze, S., Leys, R., Watts, C. H. S. and Humphreys, W.F. (2002). Islands under the desert: molecular systematics and evolutionary origins of stygobitic beetles (Coleoptera: Dytiscidae) from central Western Australia. *Invertebrate Systematics* 16: 589-598.

Humphreys, W.F. (2008). Rising from Down Under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. Invertebrate Systematics 22:85-101.

Javidkar, M., King, R.A., Cooper, S.J.B., Humphreys, W.F., and Austin, A.D. (2017). Taxonomy of *Paraplatyarthrus* Javidkar and King (Isopoda: Oniscidea: Paraplatyarthridae) with description of five new species from Western Australia, and comments on Australian *Trichorhina* Budde-Lunde, 1908 (Platyarthridae). Zootaxa 4243 (3): 401–431. https://doi.org/10.11646/zootaxa.4243.3.1

Ortuño VM, Gilgado JD, Jiménez-Valverde A, Sendra A, Pérez-Suárez G, Herrero-Borgoñón JJ. (2013). The "Alluvial Mesovoid Shallow Substratum", a New Subterranean Habitat. PLoS ONE 8(10): e76311. doi:10.1371/journal.pone.0076311

Watts, C. H. S. and Humphreys, W. F. (2004). Thirteen new Dytiscidae (Coleoptera) of the genera *Boongurrus* Larson, *Tjirtudessus* Watts & Humphreys and *Nirripirti* Watts & Humphreys, from underground waters in Australia. *Transactions of the Royal Society of South Australia* 128: 99-129.

Watts, C.H.S., and Humphreys, W.F. (2006) Twenty-six new Dytiscidae (Coleoptera) of the genera *Limbodessus* Guignot and *Nirripirti* Watts and Humphreys, from underground waters in Australia. *Transactions of the Royal Society of Australia* 130: 123-185.

Western Australian Museum (WAM). (2021a). Crustacean database search, June 2021.

Western Australian Museum (WAM). (2021b). Arachnida and Myriapoda database search, June 2021.