

23 July 2015

Toro Energy Ltd
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Attention: **Alan Tandy**
 Environmental Scientist

Dear Alan,

As discussed, the purpose of this letter is to present a review of the impacts to troglofauna arising from the proposed Wiluna Uranium Project, including mining at Millipede, Centipede, Lake Way, West Creek and Lake Maitland, and groundwater drawdowns associated with all mining activities.

For more detailed information regarding the stygofauna environmental impacts assessments undertaken for each of the project areas please refer to the following reports:

Millipede – MWH (2015) *Wiluna Uranium Project: Millipede Targeted Subterranean Fauna Assessment*.

Centipede, Lake Way and West Creek Borefield – Outback Ecology (March 2011) *Wiluna Uranium Project Subterranean Fauna Assessment*.

Lake Maitland – Outback Ecology (March 2012) *Lake Maitland Uranium Project Level 2 Troglofauna Assessment*.

Yours sincerely

Nick Stevens

MWH Australia Pty Ltd



1.1 POTENTIAL DIRECT IMPACTS ON TROGLOFAUNA

The two potential impacts of the development of the proposed Wiluna Project on troglofauna in the mining operations areas are the direct removal of habitat through mining excavation in the resource areas and the lowering of the groundwater table through mine pit dewatering or project water supply. Removal of habitat through mining excavation poses the greater risk to the conservation of troglofauna species, compared to the lowering of the groundwater table only, because excavation would directly reduce the extent of habitat available.

Troglofauna are considered to represent relictual fauna related to surface dwelling (epigean) groups that have evolved to be obligate inhabitants of subterranean environments that provide more constant and humid refugia (Humphreys 2000). The reliance of troglofauna on stable and relatively high humid conditions can make them susceptible to artificially changing water tables, particularly if the lowering of the water table is of a sufficient magnitude to dry out the inhabited zone which could have significant impacts on any troglofauna species present (EPA 2007). Groundwater drawdowns are considered to have greater impacts on stygofauna compared to troglofauna because lowering of the groundwater table can directly reduce the extent of habitat available. In the case of troglofauna, the lowering of the water table could mean that portions of saturated geology containing suitable habitable voids will become unsaturated and potentially available for colonisation.

CENTIPEDE MINING AREA

Findings

Nine species of troglofauna were recorded from the Centipede project survey area. The distributions recorded and conservation status in relation to the Centipede impact zones were as follows:

- Centipede mining pits — Five species were recorded from within the proposed pit boundaries. Of these, three species, *Haloniscus* sp. OES3, *Haloniscus* sp. OES9 (Isopoda), and Projapygidae (Diplura) were only recorded from within the proposed Centipede mining pits and therefore are of conservation concern;
- Groundwater modelled drawdown contour greater than 0.5 m — Three species, *Haloniscus* sp. OES10, *Tyrannochthonius* sp. OES3 (Pseudoscorpionida), and Symphyla were all only recorded from within the modelled groundwater drawdown contour exceeding 0.5 m bSWL and therefore may be considered to be of conservation concern; and
- Outside proposed impact zones — Three species, Lophoproctidae-OES1 (as Polyxenida in Outback Ecology (2011); wider distribution demonstrated discussed in MWH (2015)), Pauropodina, and ?*Trinemura* (*Zygentoma*) taxa are known to occur from outside the proposed Centipede mining pits and associated 0.5 m modelled (with no barriers) groundwater drawdown contour impact zones and therefore are not considered to be of conservation concern.

Mining Excavation

The removal of habitat through mining excavation poses a risk to three of the nine troglofauna species recorded from the Centipede mining area. The three species of conservation concern, *Haloniscus* sp. OES3, *Haloniscus* sp. OES9 (Isopoda), and Projapygidae (Diplura), because their distributions have not been recorded from beyond the proposed mining area were predominantly from litter traps deployed at shallow depths (1 m), in compact fine grained alluvial sediments of the delta area fringing the Lake Way playa. The projapygid specimen was the exception being collected in a net haul. The groundwater levels at sites in the low-lying delta areas fringing the lake playa were a maximum of 2 m below ground level. This meant little or no unsaturated calcrete habitat was available in these locations above the water table for true 'troglobitic' species to inhabit. The absence of habitat considered suitable for troglofauna (such as calcretes with reasonably interconnected and humid subterranean air filled voids) in the areas sampled suggests these species may be soil dwelling fauna (edaphobites), and not obligate inhabitants of subterranean environments (troglobites) that are considered to be more restricted in distribution and confined to the calcrete habitat only. These species are likely to be more widely distributed and not restricted to the mining areas considering they have been shown to not be confined to the calcrete habitat and that the habitat they have been collected from is contiguously present adjacent to the mining pits and has a relatively widespread extent fringing the Lake Way playa.

If the three restricted species, *Haloniscus* sp. OES3, *Haloniscus* sp. OES9 (Isopoda), and Projapygidae (Diplura), do only occur in the Centipede mining area, then the long term persistence of these species would be at risk because of the lack of habitat that would remain undisturbed within the resource area after mining has occurred. However, it is considered unlikely that the distributions of these three species are only restricted to the immediate vicinity of the delta area from which they were collected because of the occurrence of similar delta habitat along the calcrete-lake playa interface to the north and south of the centipede mining impact area. Therefore, the proposed mining of the Centipede resource area is not considered likely to pose a long term conservation risk to *Haloniscus* sp. OES3, *Haloniscus* sp. OES9 (Isopoda), and Projapygidae (Diplura).

Groundwater Drawdown

Groundwater drawdowns of less than 0.5 m bgl fall within the natural variation in standing water levels recorded from the mining operations area, with fluctuations commonly ranging from ± 0.1 to 0.3 m bgl, with less common variations occurring in the range of ± 0.6 to 1.26 m bgl. Groundwater drawdowns that exceed the natural variation as a result of human activities are considered to represent a potential impact on troglofauna by reducing the humidity of the inhabited zone which could have significant impacts on any troglofauna species present. The potential removal of habitat through the lowering of the groundwater table through mine pit dewatering poses a risk to three species, *Haloniscus* sp. OES10, *Tyrannochthonius* sp. OES3 (Pseudoscorpionida), and Symphyla whose distributions were not recorded from beyond the 0.5 m modelled drawdown zone.

The modeled drawdowns associated with the proposed mining of the Centipede resource area are not considered likely to pose a long term conservation risk to the species of troglofauna found within the 0.5 m groundwater drawdown contour for the following considerations:

- the depth of the modeled groundwater drawdowns are not considered to be of a large enough magnitude to lower the relative humidity to such a degree to render the subterranean environments within the 0.5 drawdown contours uninhabitable by members of the troglofauna assemblage recorded;
- the proposed lowering of the groundwater could expose additional calcrete habitats that may be colonised; and
- the existence of adjacent calcrete habitat remaining outside the lateral extent of the 0.5 m groundwater drawdown contour.

1.2 MILLIPEDE MINING AREA

Findings

A total of four specimens representing three species from three higher level taxonomic orders were collected by the 2015 targeted survey. Troglofauna were collected from only two litter traps and one net scrape sample from three of the 14 bores sampled. Two species, the polyxenid pincushion millipede, Lophoproctidae-OES1, and the pseudoscorpion *Tyrannochthonius*-OES3, were collected from two of the seven bores sampled within the proposed Millipede pit. All three troglofauna species were collected in previous surveys of the Hinkler Well calcrete (Outback Ecology 2011).

No species of troglofauna were considered of conservation concern in the context of the extension of the Wiluna project with the proposed implementation of the Millipede deposit development, as all species were found to be distributed beyond the proposed pit boundary.

The distributions of the troglofauna species recorded from the targeted survey are consistent with the geological assessments of the area that indicated that the proposed Millipede mining area forms a connected habitat extension of the broader Hinkler Well calcrete delta. The distributions of the only troglofauna species recorded from within the proposed Millipede pit, Lophoproctidae-OES1, and *Tyrannochthonius* sp. OES3, both extend beyond the proposed pit boundary.

Lophoproctidae-OES1 is considered conspecific with polyxenid material from Lake Violet and Uramurdah calcretes (previously designated as Polyxenida in Outback Ecology (2011)) and is unlikely to be a be short range endemic (SRE) as genetic analysis indicated sequenced specimens were part of a widespread species whose distribution extended to the Pilbara (Leijs *et al.* (2012) reported in Outback Ecology (2012c)). Within the Hinkler Well calcrete, Lophoproctidae-OES1 has been recorded from within the modelled 1 m groundwater drawdown contour and the proposed Millipede pit boundary only. However, the broader distribution of Lophoproctidae-OES1 beyond the Hinkler Well calcrete means this species is not of conservation concern in relation to the proposed Millipede and Centipede developments.

Tyrannochthonius-OES3 has been relatively commonly collected from the Hinkler Well calcrete delta region which has been more intensively sampled than the western calcrete portion. Genetic analysis confirmed that *Tyrannochthonius*-OES3 was a separate species to *Tyrannochthonius* material collected from Lake Violet, Uramurdah and Barwidgee calcrete areas and indicated that each calcrete hosted an SRE pseudoscorpion species (Leijs (2011) in Outback Ecology (2012b)). This strong geographic pattern indicative of short range endemism within *Tyrannochthonius* in Western Australia was further illustrated by Harrison *et al.* (2014) that also included material from Lake Violet and Uramurdah calcretes.

Tyrannochthonius-OES3 was previously considered a species of potential conservation concern as it had not been collected from outside the modelled 1 m groundwater drawdown contour associated with the development of the Centipede mining area (Outback Ecology 2011). The risk assessment conducted concluded that *Tyrannochthonius*-OES3 was not at risk by the implementation of the project due to the greater extent of suitable habitat present outside the proposed impact zone as well as the extent of suitable habitat that would remain for troglifauna within the modelled groundwater drawdown contours. The collection of *Tyrannochthonius*-OES3 from the Millipede deposit provides further confirmation that the pseudoscorpion species is more broadly distributed within and around the Hinkler Well calcrete and not confined to the proposed deposit areas only. This species is not considered here to be a species of conservation concern.

1.3 LAKE WAY MINING AREA

Findings

Nine troglomorphic species were recorded from the Lake Way project survey area. All but one of these species, *Haloniscus* sp. OES6 (Isopoda), were found to occur outside the Lake Way mining area. *Haloniscus* sp. OES6, known from a single specimen, was collected from similar habitat to the putative soil fauna species within the Centipede project survey area. The specimen was collected in a net haul sample from site AC09LW011 which intercepted the groundwater level at 2 m below the surface. The overlying geology was compact fine grained alluvial sediments in which extensive suitable troglifauna habitat would be absent. *Haloniscus* sp. OES6 is more likely to be an edaphobite rather than a troglobite. Because of the ecological niche likely to be occupied and the relatively widespread extent of adjacent and similar habitat fringing the Lake Way playa, it is considered unlikely that *Haloniscus* sp. OES6 would be restricted to the mining area only. Therefore, this species is not considered to be a species of conservation concern.

1.5 LAKE MAITLAND MINING AREA

Findings

Nine troglifauna species from five orders were collected from the Barwidgee calcrete system. All troglifauna collected were from within calcrete habitats associated with the Barwidgee calcrete system or from fine grained sediments fringing the northern Lake Maitland playa. No troglomorphic species were found to occur in the upper tributary catchment area to the north of Lake Maitland associated with the

proposed borefield, which is characterised by weathered basement geologies of the Yandal greenstone belt (Golder Associates 2011).

Of the nine troglofauna species collected:

- Three species (33%) were recorded from the resource area;
 - Scolopendridae sp. OES1 – only recorded from within the resource area;
 - *Haloniscus* sp. OES12 – found outside the resource area but not beyond the proposed 0.5 m drawdown contour; and
 - *Trichorhina* sp. OES6 – found to be widespread outside the resource and 0.5 m drawdown contour areas.
- Six species (66%) from within the associated 0.5 m groundwater drawdown contour;
 - Two of which, *Haloniscus* sp. OES12 and *Trichorhina* sp. OES6, have been referred to above;
 - *Haloniscus* sp. OES14, and Pauropoda sp. – recorded only from within the 0.5 m groundwater drawdown contour but well outside the resource area and 1 m drawdown contour;
 - *Tyrannochthonius* sp. OES5 – recorded from just outside the resource area but within the 1 m groundwater drawdown contour only; and
 - *Tyrannochthonius* sp. OES4 – recorded from just outside the resource area but also found from beyond the 0.5 m groundwater drawdown zone.
- Four species (44%) were recorded from outside the mining operations impact zones within the western portion of the Barwidgee calcrete system;
 - Two of which, *Trichorhina* sp. OES6 and *Tyrannochthonius* sp. OES4, as mentioned above, were also found to be distributed in the mining operations impact zones;
 - Meenoplidae sp., and *Tyrannochthonius* sp. OES6 – only found to occur outside of the mining operations impact zones.

Three species were collected as singletons, meaning they were represented by a single specimen only.

These species were:

- Scolopendridae sp. OES1, which as mentioned above, was the only species not found to occur outside the resource area;
- *Tyrannochthonius* sp. OES5, which was found close to the resource area within the 1 m groundwater drawdown contour; and
- *Tyrannochthonius* sp. OES6, which was one of two species not found within the mining operations impact areas.

Taxa Of Conservation Concern

The two potential impacts of the proposed development on troglifauna in the mining operations area are the direct removal of habitat through mining excavation in the resource area and the lowering of the groundwater table through mine pit dewatering. Both impacts pose varying degrees of risk to the conservation of five of the nine troglomorphic species collected that were restricted in distribution to within the:

- resource area — Scolopendridae sp. OES1;
- 1.5 m groundwater drawdown contour zone — *Haloniscus* sp. OES12; and
- 0.5 m groundwater drawdown contour zone — *Haloniscus* sp. OES14, Pauropoda sp., and *Tyrannochthonius* sp. OES5.

The remaining four troglifauna species, Meenoplidae sp. OES1, *Trichorhina* sp. OES6, *Tyrannochthonius* sp. OES4 and *Tyrannochthonius* sp. OES6, are not of conservation concern because their distributions were demonstrated to extend beyond, or to not occur within, the LMUP impact zones.

Mining Excavation

Only one species, the troglomorphic centipede, Scolopendridae sp. OES1, was found from within the resource area only. The centipede was represented by a single specimen collected from LMAC0504 in calcrete habitat that would be subjected to direct removal through mining excavation. If Scolopendridae sp. OES1 does only occur in the resource area, then the long-term persistence of this species would be considered unlikely because of the lack of available unsaturated calcrete habitat that would remain within the resource area after mining has occurred. However, the distribution ranges and habitat preferences of species collected in such low numbers are difficult to reliably assess. The seemingly restricted distribution of a species to a single bore is likely to be an artefact of that species occurring at low population densities and possessing an irregular distribution in response to varying habitat factors, biological interactions and availability of energy resources, similar to factors influencing stygofauna distributions (Boulton 2000, Boulton *et al.* 1998, Humphreys 2009), rather than the actual distribution being confined to one limited area that perchance was intercepted by a single bore.

The occurrence and wider distribution from outside the resource area of other members of the troglifauna assemblage that were also recorded from in or around the resource area, notably *Trichorhina* sp. OES6, *Tyrannochthonius* sp. OES4 and *Haloniscus* sp. 12, indicate that the relatively extensive calcrete present provides contiguous and suitable habitats that extend from along the margins of the northern lake playa system to the west along the Barwidgee calcrete. Although a wider distribution range for Scolopendridae sp. OES1 was not demonstrated by this study, nor from other accessible records for the area, it is likely the distribution range of this species is of wider extent within the Barwidgee calcrete — Lake Maitland playa system and not confined to the immediate vicinity of the bore from which it was collected.

The proposed mining of the resource area is not considered likely to pose a long term conservation risk to *Scolopendridae* sp. OES1 when taking into consideration the:

- wider distribution of other members of the troglofauna assemblage throughout the calcrete habitats and associated lake playa environments; and
- limited area of calcrete habitat removal associated with mining excavation, relative to the much greater expanse of adjacent calcrete habitat remaining.

Groundwater Drawdown

There were four species found to date only from within the modelled 1.5 m or 0.5 m groundwater drawdown contours. These were:

- *Haloniscus* sp. OES12 – collected from bores at LMAC0527 and LMAC0312 within the resource area, as well as from bore LMAC0449 located more than 100 m from the boundary of the resource area within the modelled 0.5 to 1 m groundwater drawdown contours;
- *Haloniscus* sp. OES14 – recorded within the modelled 0.5 to 1 m drawdown contours more than 950 m (LMAC0543) and 750 m (LMAC0403) from the resource area;
- *Pauropoda* sp. – recorded within the modelled 0.5 to 1 m drawdown contours more than 2.3 km (LMST012) and 900 m (LMAC0404) from the resource area; and
- *Tyrannochthonius* sp. OES5 – single specimen collected from bore LMAC0523 located more than 100 m from the resource area within the modelled 1.5 to 2 m drawdown contours.

The magnitude of the proposed groundwater drawdown associated with the mining of the LMUP resource area is not considered to be sufficient to deprive the inhabited subterranean environments of a sufficiently high relative humidity that would otherwise render them uninhabitable. In the case of the troglofauna recorded from the LMUP, the lowering of the water table will mean a portion of the saturated calcrete present, known to host a diverse stygofauna assemblage (Outback Ecology 2012a), will become unsaturated and could provide an increase in available habitat.

For each of the four troglofauna species recorded only from within the 1.5 m or 0.5 m groundwater drawdown zones, bore lithologies and standing water levels recorded indicate:

- *Haloniscus* sp. OES12 – drawdown of 0.5 to 1 m at bore LMAC0449 would lead to additional 0.5 to 1 m of calcrete becoming unsaturated with 1.2 to 0.7 m remaining saturated;
- *Haloniscus* sp. OES14 – drawdown of 0.5 to 1 m at bore LMAC0403 and LMAC0543 would lead to additional 0.5 to 1 m of calcrete becoming unsaturated with 1.85 to 1.35 m, and 1.1 to 0.6 m remaining saturated, respectively;
- *Pauropoda* sp. – drawdown of 0.5 to 1 m at bore LMAC0404 would lead to additional 0.5 to 0.85 m of calcrete becoming unsaturated with 0.35 to 0 m remaining saturated; and

- *Tyrannochthonius* sp. OES5 – Drawdown of 1.5 to 2 m at bore LMAC0523 indicates that additional 1.5 to 2 m of calcrete would become unsaturated with 5.37 to 4.87 m remaining unsaturated.

The modeled drawdowns associated with the proposed mining of the resource area are not considered likely to pose a long term conservation risk to the species of troglofauna found within the 0.5 m groundwater drawdown contour for the following considerations:

- the depth of the modeled groundwater drawdowns are not considered to be of a large enough magnitude to lower the relative humidity to such a degree to render the subterranean environments within the 0.5 to 2 m drawdown contours uninhabitable by members of the troglofauna assemblage recorded;
- the proposed lowering of the groundwater will expose additional calcrete habitats that could be colonised;
- the wider distribution of other members of the troglofauna assemblage throughout the calcrete habitats and associated lake playa environments; and
- the existence of adjacent calcrete habitat remaining outside the lateral extent of the 0.5 m groundwater drawdown contour.

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