



21 April 2016

INDEPENDENT REVIEW, WILUNA EXPANSION PROPOSAL: ASSESSMENT OF POTENTIAL IMPACTS ON SUBTERRANEAN FAUNA

1. INTRODUCTION

Toro Energy Limited (Toro) proposes to develop two satellite mine pits, a water supply borefield and a nominal 100 km long access/haul road to extend uranium mining and processing activities approved under Ministerial Statement 913 and Commonwealth approval number EPBC 2009/5174.

The Wiluna Extension Proposal was referred to the EPA in February 2014. A scoping document was prepared for the Proposal and was approved in February 2015. Toro conducted investigations in accordance with the scoping document and prepared an environmental review document (PER) which was exhibited publicly from 16 November 2015 to 8 February 2016.

On 10 March 2016 the Office of the Environmental Protection Authority (OEPA) forwarded to Toro submissions received on the PER. In addition to providing Toro with a compilation of public and regulator comments, the OEPA has recommended that Toro should engage an independent expert to review the survey work and mitigation approach to potential impacts to subterranean fauna from implementation of the Proposal.

This report provides an independent review of the survey work and mitigation approach associated with the Proposal.

2. SCOPE AND OBJECTIVES OF REVIEW

The scope of the review, as defined by Toro, is to provide advice on two matters.

1. The environmental studies carried out to characterize subterranean fauna in the project area; and
2. The management measures proposed by Toro to avoid, minimize and rehabilitate impacts to subterranean fauna in the project area.

The more detailed objectives of the review relate to five questions.

- a) Has the Wiluna Extension PER adequately characterized the extent and values of subterranean fauna potentially impacted by implementation of the proposal?
- b) Has the Wiluna PER provided a scientifically robust estimation of potential impacts on subterranean fauna?
- c) Are the measures proposed by Toro to avoid, mitigate, monitor and rehabilitate impacts on subterranean fauna or their habitats appropriate, based on current scientific knowledge and consistent with contemporary practice?



- d) Have residual impacts on subterranean fauna been assessed in accordance with EPA offsets policy?
- e) [Have] the application of the precautionary principle and the principle of the conservation of biological diversity and ecological integrity [been applied] to the assessment?

3. REVIEWER'S QUALIFICATIONS AND EXPERIENCE

This review has been undertaken by Stuart Halse, Managing Director of Bennelongia Environmental Consultants.

Stuart has a B.Sc. (Hons) degree, majoring in Zoology, from the University of Western Australia and a Ph.D. in Zoology from the University of the Witwatersrand, Johannesburg.

Stuart worked in the Science Division of the Department of Parks and Wildlife from 1985 to 2007, finishing as a Senior Principal Research Scientist. While in the Science Division, Stuart undertook research and provided management and policy advice on wetlands, rivers and subterranean ecosystems. This included managing the stygofauna component of the Pilbara Biodiversity Survey between 2001 and 2006, as well as formulating the Department of Parks and Wildlife's technical advice in relation to assessment of projects that might potentially impact on subterranean fauna.

In 2007, Stuart set up Bennelongia Environmental Consultants with four colleagues from the Department of Parks and Wildlife. Bennelongia has produced more than 270 desktop assessments, field surveys or reviews of subterranean, short range endemic invertebrate and wetland fauna, mostly for assessment purposes. Stuart has more than 110 publications in refereed scientific journals and is currently an associate editor of the international scientific journals *Hydrobiologia* and *Subterranean Biology* and a member of the Western Australian Wetlands Coordinating Committee (advising the Minister for the Environment on wetland issues). He is also an editor of *Cave Ecology*, a book currently in preparation that will be published by Springer, and is on BioPlatforms Australia's DNA Barcoding Steering Committee.

4. SUMMARY OF INFORMATION CONSIDERED

The following documents were provided to undertake the review.

- Toro (2015) Extension to the Wiluna Uranium Project, assessment no. 2002 (CMS14025), public environmental review. Toro Energy Limited, West Perth.
- MWH (2015) Wiluna Uranium Project: targeted subterranean fauna assessment. MWH Australia Pty Ltd, Jolimont (appendix 10.11 of PER).
- Outback Ecology (2012) Lake Maitland Uranium Project stygofauna assessment. Outback Ecology Services, Jolimont (appendix 10.28 of PER).
- Outback Ecology (2012) Lake Maitland Uranium Project, Level 2 troglifauna assessment. Outback Ecology Services, Jolimont (appendix 10.27 of PER).
- Outback Ecology (2012) Wiluna Uranium Project stygofauna assessment. Outback Ecology Services, Jolimont (appendix 10.27 of PER).
- Ecologia (2014) Lake Maitland peer review - subterranean fauna. Ecologia Environment, Perth.



MWH (2016) Wiluna Extension Uranium Project: MWH responses to OEPA PER comments re subterranean fauna. 6 April 2016.

5. RESULTS OF REVIEW

Answers to the five main questions asked of the reviewer are provided below as a prelude to wider discussion of issues in the remainder of the memo.

Has the Wiluna Extension PER adequately characterized the extent and values of subterranean fauna potentially impacted by implementation of the proposal? The answer to this question is not straightforward:

- There is not a clear statement, with supporting rationale, about what constitutes the impact area for stygofauna at Hinkler Well as a result of the Extension Proposal. Similarly the framework for evaluation of cumulative impact on stygofauna at Hinkler Well is not explicit.
- Within the limitations imposed by some uncertainty about impacts, the documentation of the species within the total area of groundwater drawdown at Hinkler Well appears to be adequate, with the possible exception that DNA analysis was not undertaken for copepods. This lack of copepod DNA analysis is not considered to be a major issue.
- Documentation of species in the Lake Maitland impact area appears to be adequate, except for troglifauna in the reinjection area (although it may be argued that the impact of reinjection on troglifauna will be minimal).
- Little information is provided about the distributions of stygofauna species in the unimpacted parts of the Hinkler Well and Barwidgee PECs. EAG12 states that a Level 2 survey is "required to spatially represent the entire aquifer", including non-impacted parts of it (see Example 1, page 11 of EAG12). It may be concluded that there has been insufficient survey of non-impact areas at the Hinkler Well and Barwidgee PECs.

Has the Wiluna PER provided a scientifically robust estimation of potential impacts on subterranean fauna? The answer to this question is yes, except that possibly more use might have been made of DNA analysis to confirm some identifications.

Are the measures proposed by Toro to avoid, mitigate, monitor and rehabilitate impacts on subterranean fauna appropriate, based on current scientific knowledge and consistent with contemporary practice? Insufficient information was provided to answer this question properly. I have not seen the revised Subterranean Fauna Management Plan.

Have residual impacts on subterranean fauna been assessed in accordance with EPA offsets policy? The analysis of residual impacts in Table 1 of MWH (2016) appears to understate the possible extent of residual impacts.

- It is incorrect to say groundwater drawdown will occur in only 6% of the Hinkler Well PEC. The PER states that 11% of the PEC will be affected by mine excavation and waste dump storage and the area affected by groundwater drawdown must be larger than this figure. If the figure of 1328 ha in Table 1 represents drawdown within the PEC, then approximately 16-17% of the PEC will be impacted (assuming the PEC is about 80 km² in extent as stated by Outback Ecology 2012a).

- Full recovery of groundwater levels will take 70 years after cessation of mining, although the staged mining process means many areas will experience shorter recovery times. However, there is not good evidence that the full suite of species currently present will persist in, or recolonise, recovered drawdown areas at the Hinkler Well and Barwidgee PECs. The apparent persistence of (some) species after short-term water level fluctuations at Lake Violet and Ethel Gorge does not mean the integrity of the Hinkler Well and Barwidgee PECs will necessarily be restored in the forthcoming decades.

[Have] the application of the precautionary principle and the principle of the conservation of biological diversity and ecological integrity [been applied] to the assessment? The principles of conservation of biological diversity and ecological integrity underlay the assessment. Ranges of species were inferred using surrogate information with a 'balance of probability' approach. This is not the most conservative way of applying the approach of the precautionary principle but it is widely used in assessment. The effect of disturbance on ecological integrity of PECs was considered, although possibly the extent of residual impact was underestimated.

5.1. Approach Taken by PER

Overall, the PER deals with subterranean fauna issues in a rather disjointed fashion, with some of the necessary contextual information about hydrogeology and impact areas in other PER chapters. A more coherent and standalone account of subterranean issues would be useful, although this would result in some duplication of information across PER chapters.

5.1.1. Defining Impact Areas

Assessment of troglifauna in the PER is relatively straightforward but assessment of stygofauna impacts at Millipede is made difficult by two aspects of impact area definition. The issues were:

- *Classes of impact.* Treating pit excavation as a direct impact and groundwater impact as an indirect impact on stygofauna does not follow EAG12, where groundwater drawdown in classed as a direct impact (see section 3.3.2 on page 9 of EAG12). While under some circumstances animals may survive dewatering, in most assessments stygofauna habitat is treated as lost wherever significant (i.e. greater than designated threshold) groundwater drawdown occurs.
- *Previous assessment.* Groundwater drawdown associated with the Wiluna Uranium Project at Centipede has already been assessed and approved but there is not a clear statement in the PER about how this shapes the current assessment. Previous assessment for the Wiluna Uranium Project covered most of the area of groundwater drawdown, including the proposed mine pit, that is being assessed in the current PER. No information is provided about how much additional drawdown will occur as a result of Millipede mining (although this information was provided to me by Toro and is described elsewhere in this review).
- *Was the appropriate area assessed.* There has been no assessment of whether any stygofauna are possibly restricted to the additional drawdown area associated with the Wiluna Extension. However, Toro advised me that the approach was to treat all areas of groundwater drawdown around Centipede and Millipede as the cumulative impact of mine dewatering. In this approach, there was a focus on species restricted to the mine pit, which lies within a previous



groundwater drawdown approval, but species in other parts of this drawdown appear at times to be treated as previously assessed rather than subject to cumulative impact.

5.1.2. Reinjection

There is potentially inadequate examination of the possible effects of reinjection of groundwater at Lake Maitland. The PER simply states *"The reinjection of hypersaline water into fresh water systems has the potential to cause local increases in the salinity of shallow groundwater, which could reduce the suitability of the shallow aquifer for some subterranean fauna"*.

It is stated on page 12-41 both that *"the aquifer [is] capable of receiving up to 1 GL/a for 15 years without ... significant groundwater mounding"* but it is stated on page 12-35 in relation to reinjection of less than 1 GL/a that *"At cessation of reinjection, mounding of the groundwater table in the reinjection area would gradually dissipate and the water table would recover to pre-injection levels."* Table 3.5 of the Executive Summary describing the operational elements of the project at Lake Maitland indicates that up to 4 GL/a of reinjection may occur, although Toro informed me that in practice no more than 1 GL/a will be reinjected.

Given the uncertainties about the extent and impacts of groundwater reinjection, it would be expected that both stygofauna and troglofauna surveys would have occurred in the reinjection area. However, the sampling results obtained elsewhere at Lake Maitland provide additional context and suggest (with hindsight) that:

- Stygofauna sampling in the reinjection area is not required (Figure 12.4).
- Troglofauna sampling should be undertaken in the reinjection area (Figure 12.5), unless a formal assessment of habitat shows the reinjection area does not contain habitat suitable for troglofauna or the extent of habitat reduction is considered to be negligible.

5.2. Characterisation of Existing Environment

5.2.1. Impact Area Sampling

The lack of clarity about what constituted the impact areas to be assessed at Millipede (or Millipede and Centipede) under the current PER makes it difficult to assess the adequacy of sampling effort. Some bores or drill holes sampled for the previous PER were resampled without a clear explanation of the reasons for doing so.

The additional sampling at Millipede in 2015 associated specifically with the current PER consisted of:

- *Stygofauna*. A total of 17 samples were collected, of which 15 were in the area already assessed under the Wiluna Uranium Project PER and 2 were in the western part of the Hinkler Well PEC. Of the 15 samples collected in the overall area of groundwater drawdown, 9 were in the proposed Millipede mine pit, 5 were in the approved Centipede pit and 1 was in the general area of groundwater drawdown associated with Millipede.

The ICE estimator of species richness suggested that 82% of stygofauna species present in the Centipede drawdown area were collected during work for the Wiluna Uranium Project PER (Outback Ecology 2012a). This area has similar extent to the overall Centipede/Millipede drawdown area described in the Wiluna Extension PER. Sampling in 2015 would be expected to have collected a small number of additional species to those in the previous 89 samples

from the same area (and did). But at the level of effort applied, the 2015 sampling had little capacity to provide better characterisation of the community in the overall area of drawdown and did not sample any area of additional drawdown. In addition, when all sampling done for both PERs is considered, the ICE estimator implied a sampling efficiency of only 70% for the Hinkler Well calcrete (MWH 2016).

It should be noted that both Outback Ecology (2012a) and MWH (2016) provide results of a range of species estimators, many of which imply higher sampling efficiency than ICE. However, this review considers that the ICE estimator is likely to be the most appropriate of the algorithms for reasons discussed in Eberhard et al. (2009).

- *Troglofauna*. Only 6 trap and 5 scrape samples were collected from the 7 holes sampled in the proposed mine pit in 2015. Two holes in the pit were previously sampled for the Wiluna Uranium Project PER. While sampling effort is low, few troglofauna species were expected to be present (and few were collected) so that the sampling effort may be seen as adequate.

Both stygofauna and troglofauna sampling efforts in impact (and reference) areas at Lake Maitland appear to be appropriate except that reinjection has not been considered.

5.2.2. Impact on PECs

The PER provides very little information about the subterranean communities of the Hinkler Well and Barwidgee (Lake Maitland) PECs outside potential impact areas. This means that it is difficult to determine whether the impact of PEC communities will be minimal (reflecting only a small loss in the spatial extent of the PEC communities) or more significant because a sub-community occurring in a small part of a PEC will be lost. This makes estimation of residual impacts difficult unless calculated simply as the proportional reduction in area.

The current boundaries of the Hinkler Well and Barwidgee PECs appear to be defined by the extent of surface calcrete (plus a buffer), although MWH (2016) indicated that the extent of saturated calcrete was also taken into account. More information about the information used to define the PECs is provided in the PER.

While surface calcrete is easily mapped, the extent of the stygofauna communities is more likely to be determined by the spatial extent of saturated calcrete. While mine pits at both Hinkler Well and Lake Maitland appear to extend beyond even the PEC buffer zones, it is likely all mine pit and most groundwater drawdown (other than the Lake Maitland borefield) occurs within the PEC communities (Figures 12.13 and 12.14).

5.2.3. Use of DNA Analysis

Given that extensive radiations of copepods are known from Yeelirrie and some other calcretes in the Yilgarn, with some species recognised first through genetic analysis (Karanovic and Cooper 2011, 2012, Karanovic et al. 2014), it is surprising that DNA analysis of copepods was not undertaken. DNA was used for some other stygofaunal groups. While the morphological identifications of copepods were made by the principal expert on Western Australian subterranean copepods and should be regarded as authoritative, the assessment might be stronger with DNA support.

Toro have said that DNA analysis was not used because some of the copepods collected for the Wiluna Uranium Project PER are too old for DNA analysis, limiting the capacity to compare specimens collected in 2015 with earlier specimens. It would still have been useful to get potentially finer taxonomic discrimination from DNA for 2015 material.

5.3. Identification and Characterisation of Threatening Factors

5.3.1. Groundwater Drawdown

The PER states *"Dewatering at Millipede would comply with the approved drawdown as determined in Assessment [913] and EPBC 2009/5174. The implementation of groundwater barriers would ensure that flows were restricted and dewatering limited to that already approved."* This represents a best case scenario and it is said that the more conservative case is presented elsewhere in the PER. Although not clearly shown in the PER, the positions of the 0.5 m drawdown contour associated with the Wiluna Uranium Project and conservative case for the Wiluna Extension are different. Comparison of Figure 12.3 of the PER and Figure 4 of Outback Ecology (2012a) shows drawdown as extending 500-600 m farther west as a result of Millipede dewatering. Table 3.3 of the Executive Summary of the PER states that in addition to the 1.8 GL/a of dewatering from Centipede and Lake Way, an extra 2 GL/a of dewatering would occur at Millipede but Toro stressed to me that this represents a worst case scenario, with management measures expected to constrain dewatering volumes to existing, approved levels.

It is repeatedly stated in sections dealing with sampling effort (e.g. page 12-28 of PER) that groundwater drawdown is a potential impact on troglofauna and then stated in sections dealing with assessment (e.g. page 12-39) that it is not an impact and probably results in the creation of additional; habitat. The latter view is likely to be correct (although supporting reasoning is not provided by the PER) and for the purpose of documenting troglofauna sampling effort only mine pits and, possibly, areas of groundwater reinjection, should be considered as impact areas.

It may be useful to undertake an analysis of the implications of groundwater drawdown on subterranean humidity to quantify the effects of drawdown on troglofauna habitat but this review considers it is unlikely there will be any reduction in humidity. Lower humidity is the mechanism by which groundwater drawdown is considered to reduce the suitability of troglofauna habitat.

5.3.2. Determining Drawdown Threshold

The key issues in determining the drawdown threshold that will be acceptable to stygofauna in calcrete areas are:

- *Thickness of the saturated calcrete layer.* The data provided in the PER text on depth to calcrete, calcrete thickness and depth of the watertable suggest the saturated calcrete is about 2 m thick in the area of groundwater drawdown at Millipede, although Figure 12.8 shows a maximum thickness of about 0.8 m. The maximum thickness of saturated calcrete shown in cross-sections of Lake Maitland is 2.5 m and much of the area has 1 m or less. Quantification of the thickness of calcrete across the areas of groundwater drawdown associated with both mine sites would be useful.

As an assessment process, the objective of maintaining at least 70% of the saturated thickness of the aquifer (MWH 2016) is assumed not to be achieved at all in the impact area but to be achieved in most of the surrounding zone where drawdown is < 0.5 m:

- While this is a standard interpretation, it should be recognised that in the particular situations of Hinkler Well and Lake Maitland it is likely that thickness of saturated calcrete will be considerably less than 0.5 m in some areas near the periphery of the calcrete where drawdown is only slightly less than 0.5 m. This means that even outside the impact area, as defined by a drawdown threshold of <0.5 m, there may be significant loss of stygofauna habitat. Detailed calcrete mapping would be required to determine the frequency of this situation).
- *Extent of natural fluctuations in baseline groundwater levels.* It is only the variation in baseline watertables as a consequence of drought that are important when considering impacts of groundwater drawdown. Short-lived upward spikes in water level as a result of pulses of recharge after cyclones have little bearing on the tolerance of the fauna to drawdown. The PER does not specifically refer to the effects of drought and cites Appendix A in Outback Ecology's (2012a) specialist report for the Wiluna Uranium Project for evidence of watertable variation. Appendix A provides depths of groundwater recorded during stygofauna sampling and shows some large variations were observed during stygofauna sampling, with water levels in August 2010 often being quite low after a moderately prolonged drought (e.g. 0.9 m lower than the highest groundwater level at bore NLW22). Most changes were much smaller and contradictory temporal patterns were sometimes observed with water levels after rain being lower in January 2012 than in the dry August 2010 (e.g. bore NLW16). However, overall it appears that the Millipede (and probably the Lake Maitland) area experiences natural variations in baseline water levels of more than 0.5 m. MWH (2016) provide additional supporting information.

5.4. Assessment of Potential Direct and Indirect Impacts

5.4.1. Millipede

Assessment of potential impacts on stygofauna caused by the Wiluna Extension at Millipede is focussed on the Millipede mine pit itself, which is inside the area already approved for disturbance (i.e. groundwater drawdown) under the Wiluna Uranium Project. As stated previously, it is considered that the focus should be the area of additional drawdown, especially the band 500-660 m wide to the west and south of approved drawdown.

The PER presents only one stygofauna species (Chiltoniidae SAM6) as potentially restricted to the impact area at Millipede although 5 stygofauna species are known only from the area of groundwater drawdown around the Centipede and Millipede mine pits (Table 1) and may be considered potentially threatened by drawdown.

Chiltoniidae SAM6 was collected within the proposed Millipede mine pit. The reason for presenting this species as potentially threatened in Table 12.5 but not *Schizopera* TK7, which is known only from the area of groundwater drawdown, is not stated. *Schizopera* TK7 was collected during the sampling for both the Wiluna Uranium Project PER and the current PER only within the area of groundwater drawdown >0.5 m. Other species collected only from the area of groundwater drawdown during the

sampling for the Wiluna Uranium Project PER are excluded from consideration in the current PER (see Table 1). This does not reflect the degree of threat to the species and does not sit comfortably with the cumulative impact approach Toro has suggested it is using.

As a comment, there is scattered but quite consistent information emerging that amphipods are relatively widespread within individual calcrete aquifers compared with some copepods. Therefore, although there is currently no sampling evidence that Chiltoniidae SAM6 extends beyond the mine pit and area of groundwater drawdown, the biology of amphipods as a group suggest it probably does. Thus, the conclusion in the PER that Chiltoniidae SAM6 is more widespread is likely to be correct.

5.4.2. Lake Maitland

The PER states that two species (Chiltoniidae SAM4 and *Schizopera* TK1) are restricted to the impact area at Lake Maitland and, in fact, they are known only from the proposed mine pit. A third restricted species listed in Table 12.9 (*Haloniscus* sp. OES1) occurs outside the 0.5 m groundwater drawdown and Toro have clarified that it was listed by error.

While it is recognized that using surrogates to provide clear evidence of wider distribution of stygofauna species is challenging, it cannot reliably be inferred (page 12-23) that *Schizopera* TK1 is widely distributed at Lake Maitland because the other species collected from the same bores as *Schizopera* TK1 occur more widely. While the co-occurring species include the wide-ranging *Nitokra lacustris pacifica*, they also include the apparently restricted Chiltoniidae SAM4 and *Haloniscus* sp. OES1. This comment applies equally to other apparently restricted species at Lake Maitland and Hinkler Well. The justifications provided in the PER and supporting specialist reports for the species having wider distributions are very generic and would benefit for more detailed consideration of each species.

In relation to the range of *Schizopera* TK1, its collection from conductivities of 106-132 mS/cm at the top of the water column is very surprising and represents greater salinity tolerance than expected from stygofauna. Assuming a direct relationship between mS/cm and g/L (which is approximately correct at high salinities), the salinity record for *Schizopera* TK1 matches the upper salinities at which surface species of *Schizopera* are known to occur as adults in south-west WA (Pinder et al. 2005). Hatching occurs at lower salinities. While the salinity records suggest salinity is no barrier to the occurrence of *Schizopera* TK1 and the species may have a wide range at Lake Maitland, it surely requires fresher water for breeding.

5.5. Proposed Mitigation Measures

5.5.1. Impact Management

The general statement made on page 12-40 in relation to habitat loss is inappropriate, namely that "*Studies of local stygofauna and troglifauna populations have shown that most of the species observed are distributed over a wide geographic area. There is no plausible basis for assuming that species so far observed only within proposed disturbance areas are restricted to those areas (unless they are reliant on high uranium habitats).*" While it is implicit that 'wide' is being used in a relative way, existing evidence suggests that quite a high proportion of species occurring in calcretes are not distributed throughout the calcrete body in which they are found; rather they restricted to a subsection of the

calcrete body or particular habitats within it. Furthermore, it is plausible that species may have ranges of <100 km², which is the approximate area of groundwater drawdown at Centipede/Millipede. This is the case, for example, with *Kinnecaris* copepod species at Yeelirrie (Karanovic and Cooper 2011).

The statement made on page 12-40 that “*Toro will commit to having no impacts to stygofauna beyond the 0.5 m drawdown contour (without barriers)*” needs more context and explanation. How will this be achieved and compliance monitored?

5.5.2. Formal Commitments

The commitments that will be in the Environmental Management Plan made in the PER in relation to subterranean fauna appear to be appropriate. However, I did not have not seen the revised Subterranean Fauna Management Plan.

Table 1. Species known only from impact areas at Hinkler Well and Lake Maitland.

Millipede/Centipede	Lake Maitland	
	Stygofauna	Troglofauna
Chiltoniidae SAM6*	Chiltoniidae SAM4	Scolopendridae OES1
<i>Brevisomabathynella</i> SAM2	<i>Schizopera</i> TK1	
<i>Schizopera</i> TK4	<i>Haloniscus</i> OES1	
<i>Schizopera</i> TK7*		
<i>Schizopera</i> TK10		

6. REFERENCES

- Eberhard, S.M., Halse, S.A., Williams, M.R., Scanlon, M.D., Cocking, J.S., and Barron, H.J. (2009) Exploring the relationship between sampling efficiency and short range endemism for groundwater fauna in the Pilbara region, Western Australia. *Freshwater Biology* **54**, 885-901.
- Karanovic, T., and Cooper, S.J.B. (2011) Molecular and morphological evidence for short range endemism in the *Kinnecaris solitaria* complex (Copepoda: Parastenocarididae), with descriptions of seven new species. *Zootaxa* **3026**, 1-64.
- Pinder, A.M., Halse, S.A., McRae, J.M., and Shiel, R.J. (2005) Occurrence of aquatic invertebrates of the wheatbelt region of Western Australia in relation to salinity. *Hydrobiologia* **543**, 1-24.
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- Outback Ecology (2012a) Wiluna Uranium Project stygofauna assessment. Outback Ecology Services, Jolimont.



Outback Ecology (2012b) Lake Maitland Uranium Project stygofauna assessment. Outback Ecology Services, Jolimont.

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30 June 2016

INDEPENDENT REVIEW, WILUNA EXPANSION PROPOSAL: RESPONSE TO ADDITIONAL INFORMATION FROM MWH

Toro Energy has requested additional peer review comment on the documentation for EPA Assessment No. 2002 *Extension to the Wiluna Uranium Project*, in particular on the letter from MWH dated 27 June 2016. This additional peer review should be read in conjunction with my previous report *Independent Review, Wiluna Expansion Proposal: Assessment of Potential Impacts on Subterranean Fauna* dated 21 April 2016. That report has been edited slightly while writing the current peer review to increase clarity.

The letter from MWH addressed three issues:

1. *Additional extent of groundwater drawdown within the Hinckler Well PEC resulting from proposed Wiluna Extension*

The clarification in the MWH letter that 17.5% of the Hinckler Well calcrete PEC will be drawn down by >0.5 m as a result of the Extension to the Wiluna Uranium Project corrects an error in the PER. The additional drawdown associated the Wiluna Extension (rather than the approved Project) is only 168 ha and no species has been recorded only from this area. The single species of stygofauna collected from the one bore sampled within the area (the copepod *Metacyclops laurentisae*) is widespread in mid-western Australia. Thus, the incremental impact of the Wiluna Extension on the PEC is small (MWH states 2.2%).

The description of how dewatering at Millipede will occur in a staggered way as a result of individual drawdowns in each mining panel may imply less threat to the stygofauna populations present than is actually the case. Impact on stygofauna is likely to depend on a series of site-specific factors and the biology of the stygofauna species present. There is probably insufficient information provided in the PER to evaluate the likely impact of the successive dewatering of each mine panel rather than assessing the dewatered area as a single unit.

2. *Physical and biological surrogates*

The MWH letter provides a useful summary of the issues around estimating ranges of stygofauna species. It is considered, however, that the letter downplays the likelihood of subterranean speciation. There is evidence of sympatric (or at least parapatric/microallopatric) speciation in stygal beetles (e.g. Leijds *et al.* 2012) and probably also stygal harpacticoid copepods (e.g. Karanovic and Cooper 2012).



Millipede and Chiltoniidae SAM6

The habitat descriptions provided in the extensive text and figures of the letter highlight the likely complex, mosaic nature of subterranean fauna habitats in the groundwater drawdown and surrounding parts of the Hinckler Well PEC. MWH's review of the ranges of other amphipod species in Yilgarn calcretes suggests it is likely Chiltoniidae SAM6 is more widespread in the Hinckler Well PEC.

It should be noted that the salinity from which Chiltoniidae SAM6 was collected (32-46 g/L) is unusually high for a subterranean amphipod. Comment on the recorded salinity tolerance of *Schizopera* sp. TK1 from Lake Maitland was made in my previous report.

Lake Maitland and Chiltoniidae SAM4 and Schizopera TK1

The MWH letter states that '*The recorded saturated habitats for both Chiltoniidae SAM4 and Schizopera sp. TK1 ... are dominated by clay layers with only thin prospective habitable layers interspersed in the upper few metres*'. It is hypothesized that this limited habitat is connected to the broader Barwidgee calcrete and that both species are more widely distributed than the area of proposed groundwater drawdown.

Based on the typically wide ranges of amphipods within a Yilgarn calcrete, this is likely to be correct for Chiltoniidae SAM4. The situation is less clear for *Schizopera* sp. TK1 because four other species of *Schizopera* were recorded in the Barwidgee calcrete and, based on distributions in other Yilgarn calcretes (e.g. Yeelirrie – Karanovic and Cooper 2012, Karanovic *et al.* 2015), geographic restriction is quite likely. It is considered that the statement in the MWH letter that "*A wider distribution range ... was not demonstrated for Schizopera sp. TK1*" is correct, although as speculated by MWH the species' range may extend beyond the area of groundwater drawdown.

3. ReInjection

The summary of information and the conclusion in the MWH letter that '*the proposed groundwater reinjection scheme ... is not considered to pose a conservation issue for any species of troglofauna*' appear to be appropriate.

References

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